BELL TELEPHONE QUARTERLY

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TELEPHONE RESEARCH AND PROBLEMS OF THE DEAFENED

COMMUNICATIONS AND POLICE PROTECTION

ENGINEERING THE TELEPHONE FLEET

A DECADE OF AWARDS TO THE SCIENTISTS AND ENGINEERS OF THE BELL TELEPHONE SYSTEM

AMERICAN TELEPHONE & TELEGRAPH CO. • NEW YORK

BELL TELEPHONE QUARTERLY

A Medium of Suggestion and a Record of Progress

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Address all communications to

INFORMATION DEPARTMENT
AMERICAN TELEPHONE AND TELEGRAPH COMPANY
195 Broadway, New York

Contributors to this Issue

JOHN C. STEINBERG

Coe College, B.S., 1916, M.S., 1917. U. S. Air Service, 1917–19. University of Iowa, Ph.D., 1922. Western Electric Company, Engineering Department, 1922–25. Bell Telephone Laboratories, 1925–. Dr. Steinberg's work in the Bell System has related largely to speech and hearing.

STERLING PATTERSON

Yale University, Ph.B., 1915. Reporter, *New York Tribune,* 1915–17. First Lieutenant, U. S. Air Service, 1917–19. Western Electric Company, Public Relations Department, and Editor, *Western Electric News,* 1919–30; Editorial Director, 1930–33. American Telephone and Telegraph Company, Information Department, 1933–.

T. C. SMITH

Purdue University, B.S. in M.E., 1910. New York Telephone Company, plant extension engineering, 1910–14. Engaged in electric light and power engineering, 1914–16. New York Telephone Company, general outside plant engineering and motor vehicle operation, 1916–21. American Telephone and Telegraph Company, Operation and Engineering Department, Plant Engineering Division, 1921–. Mr. Smith's work is concerned with automotive and construction apparatus engineering.

J. O. PERRINE

University of Iowa, B.A., 1909; University of Michigan, M.S., 1915; Cornell University, Ph.D., 1921. American Telephone and Telegraph Company, Department of Development and Research, 1921–25; Information Department, 1925–. Dr. Perrine is Associate Editor of the *Bell System Technical Journal.*

TESTING THE HEARING OF SCHOOL CHILDREN.
The 4A Audiometer in use in a class room, as described in the article beginning on the opposite page.

Telephone Research and Problems of the Deafened

THE part that telephone research has played in revealing the extent of hearing impairment and in providing aids for the deafened forms an interesting chapter in Bell System achievements. It began more than twenty years ago as a comprehensive study directed toward analyzing and describing speech and hearing just as electrical circuits and telephone instruments are analyzed and described. Many advantages would accrue if the characteristics of the voice and ear could be given consideration in the engineering and design of the telephone.

It soon became evident that the study demanded better instruments than were available and a great deal of work was done toward refining instruments for translating sound waves into electrical form and vice versa. Improvement in instruments opened up new fields of study. Further study created a demand for better instruments and the cycle was repeated. It was only natural that this activity should find application and outlet in fields related to telephony.

The Measurement of Hearing

One of the first problems encountered was that of accurately measuring hearing. The tuning fork and watch tick methods employed by doctors were found to be unsatisfactory for testing people with normal hearing. A method was worked out which involved the use of a special vacuum tube oscillator, attenuator and receiver. Hearing was measured by holding the receiver to the ear and setting the attenuator so that the tone was just audible. The tone was then said to be at the threshold of hearing. From measurements upon a large number of

individuals, normal threshold settings for tones of different pitch were obtained. As a definite intensity level of sound corresponded to a given attenuator setting, the hearing of an individual was measurable in an absolute sense and also with respect to normal.

As the results of this work became generally known a demand for the methods and equipment began coming from hospitals, otologists, and others interested in hearing. To meet these needs the Western Electric Nos. 1A and 2A Audiometers,

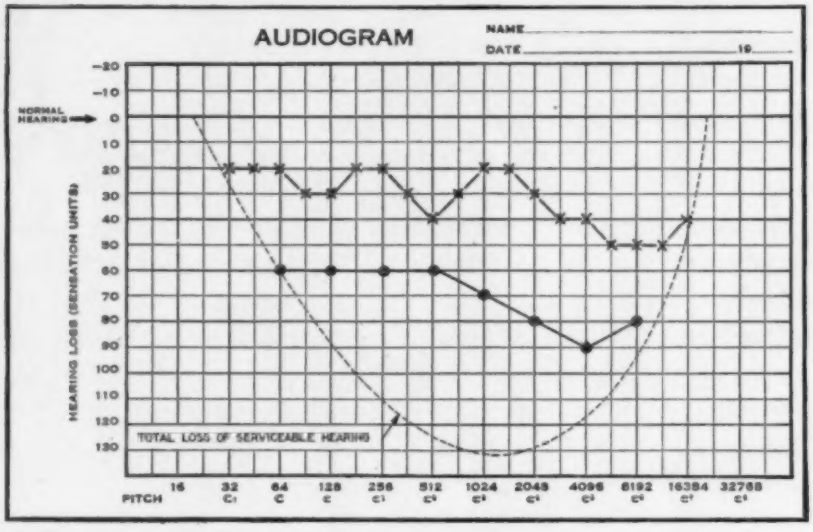


FIG. 2. AN AUDIOGRAM.

instruments which duplicated the laboratory method of testing hearing, were developed. Hearing impairment was expressed as a hearing loss in decibels (db). It is equal to the difference in the normal and deafened threshold intensity levels. A chart showing the hearing loss at various pitches was called an audiogram. Figure 1 shows the Nos. 1A and 2A Audiometers. The audiogram which may be obtained with them is shown in Fig. 2. Normal hearing is shown on the audiogram chart by a horizontal line at zero hearing loss. The dashed line shows

losses which correspond to a total loss of serviceable hearing. This means that the tones cause a sensation of feeling or pain before they can be heard. The hearing losses of an individual with moderate deafening falls between these limits. In the figure, the crosses and circles represent measurements with the Nos. 1A and 2A Audiometers respectively, upon different individuals. The two instruments are functionally alike but cover different pitch ranges.

This method of measuring and representing an individual's hearing is coming into almost universal use by doctors, in clinics and hospitals, and in researches on hearing. Frequently, for diagnostic purposes, both air and bone conduction receivers are used. With the latter receiver the vibrations are communicated to the skull bone in back of the ear, so that the ear drum and ossicles are not involved as directly as in air conduction. Differences between air and bone conduction audiograms are of use in determining whether the losses are due to middle or inner ear defects.

Another form of audiometer, known as Nos. 3A and 5A, enables the average hearing to be measured in the important part of the pitch range. This is done by using a complex tone having overtones throughout the audible range. The No. 3A is battery operated, the No. 5A operates from an electric light outlet. The field for this instrument is in quick and accurate surveys of the hearing of a large number of people. Only a single measurement is necessary and the hearing loss is expressed by a single figure.

The Hearing of School Children

Shortly after this research work was initiated, considerable interest developed in this country in the hearing of school children. A number of hard-of-hearing organizations became active advocates of tests and some states and cities passed laws requiring tests in the grade schools. It very soon became evi-

dent that individually testing the hearing of school children was impractical and some sort of a group hearing test was sought. Engineers of Bell Telephone Laboratories were approached since they had developed numerous contacts in this field, and finally a committee was formed under the sponsorship of the American Society for the Hard of Hearing to develop a group hearing test for school children. The Laboratories' member of this committee was Dr. Harvey Fletcher, who not only directed the research work in speech and hearing at the Laboratories but gave unstintingly in energy and time to adapt laboratory results to problems of the hard of hearing.

The form of audiometer shown in the frontispiece was finally evolved for testing groups of school children. It consists of an electrical phonograph which may be connected to as many as forty receivers. On listening to the receivers, the children hear a sequence of numbers which gradually diminish in loudness. They write down the numbers as long as they can hear them. The point at which they fail to hear the numbers is a measure of their hearing.

The test serves as a means of grading the children into groups ranging from normal hearing to seriously deafened. It is particularly useful in catching borderline cases where the impairment is not enough to be noticed at home or in casual classroom contact. The children having impaired hearing are given treatment by an otologist and special provisions are made in their educational program.

The movement to test the hearing of school children has spread very rapidly in recent years, particularly in the cities. It has been estimated that the hearing of more than 1,000,000 children is tested annually, by the use of No. 4A Audiometers. The use of the instrument might be said to be world wide. Hawaii reports tests on their school children and from Cape Town, South Africa, comes a report of tests in English and also in the tongue, Afrikaans, used by the Dutch settlers. In Canada tests are made in English and French.

It is difficult to convey on the printed page the things that are being accomplished by such tests. Case reports abound in instances where the test brought a child to the attention of an otologist in time to correct an incipient infection. Any number of so-called "dull" children have turned out to be "bright" when given special instruction in lip reading and seats near the front of the class.

Some Hearing Characteristics

With accurate methods of measurement available, considerable statistical data on the hearing impairment of people have accumulated. From samplings of the adult population, it has been estimated that the hearing of every tenth person is impaired sufficiently to inconvenience him in ordinary pursuits. Tests on school children show that one out of fifteen is handicapped in classroom work because of temporary or permanent hearing defects.

People seldom hear exactly alike with their two ears. One ear is usually a few decibels more sensitive than the other so that when listening with both ears a person is always certain of using his better ear. Normal hearing for audiometric uses has been based on tests with young people in the age range from 18 to 23 years. The hearing of the average young adult is most acute in the range from 2000 to 3000 cycles. As a matter of fact he has about all the hearing acuity that he can use for it has been estimated that if his hearing were 20 db more acute he would hear the air molecules bombarding his eardrums. Some individuals do almost exceed the average by 20 db, but they are very exceptional.

As one grows older he loses his ability to hear high-pitched tones. The effect of age is shown in Table I. It would appear that when we speak of normal hearing we must keep age in mind as an individual of 60 with normal hearing has a loss of 30 db in the range above 4000 cycles when compared with a

young adult. Hearing in the range below 1000 cycles appears to be affected little, if any, with age.

TABLE I

DB Loss in Hearing with Age

Frequency	60 to 1000 Cycles	2000 Cycles	4000 Cycles	8000 Cycles
Ages 20–29 (96 ears).....	0	0	6	6
Ages 30–39 (162 ears).....	0	0	16	11
Ages 40–49 (84 ears).....	0	2	18	16
Ages 50–59 (28 ears).....	0	5	30	32

One's hearing ability varies with the direction from which the sound comes. One hears best when the ear is turned toward the sound source. The effect is most pronounced at the higher frequencies.

When listening in the presence of a background noise one hears less well than in the quiet, a phenomenon known as masking. The effects are somewhat the same as a hearing loss, except that the loss vanishes when the noise is removed. Both forms of audiometers have been used for measuring the masking effect of noise. The noise in an average office in the metropolitan area causes a normal hearing person a loss of 20 to 30 db due to masking. In the presence of such a noise, a person deafened 20 to 30 db would hear as well as an individual of normal hearing.

The No. 2A Audiometer has been used by one experimenter to measure the hearing of chimpanzees. They were found to hear as well as but no better than man. Modifications of the audiometer have been used to test the hearing of cats, guinea pigs, dogs and monkeys, in several physiological laboratories in this country. Although the opinion is often expressed that animals hear better than man, accurate tests of their hearing do not confirm this. This might be expected since man's hearing acuity is near the limit set by the thermal motion of the air molecules.

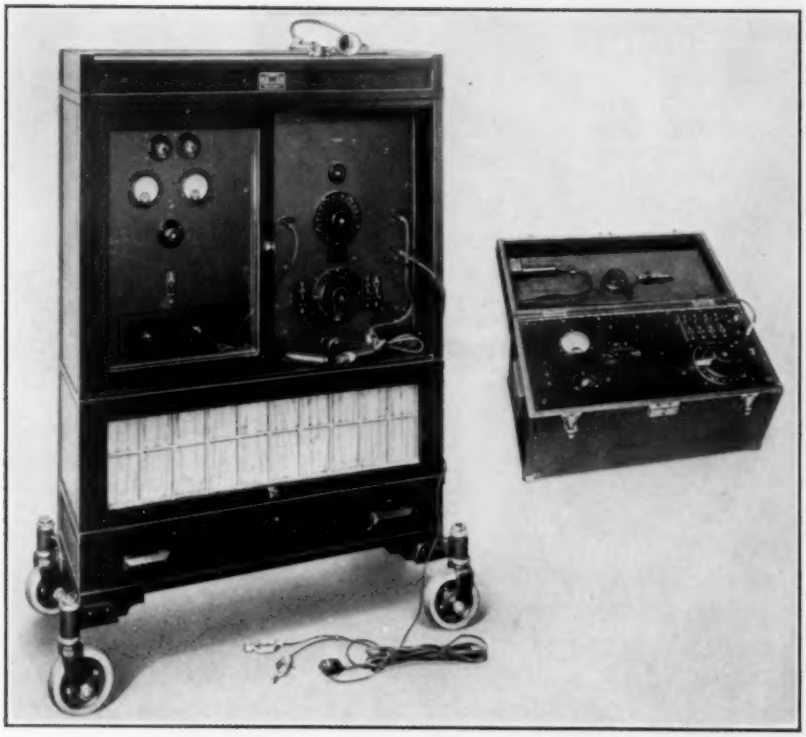
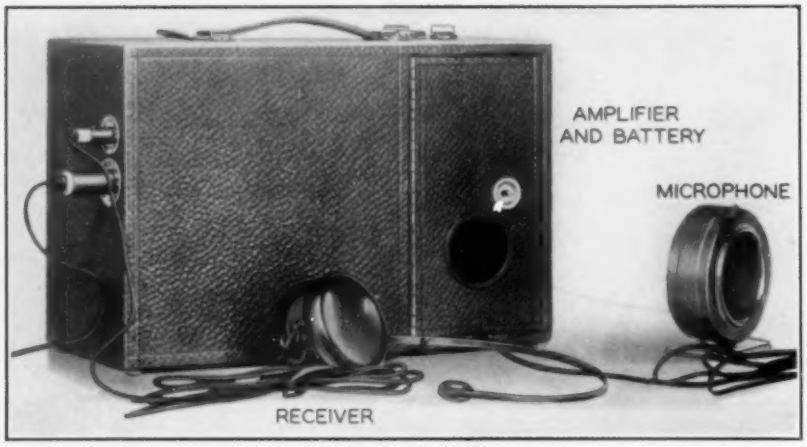


FIG. 1. THE 1A (LEFT) AND 2A AUDIOMETERS.



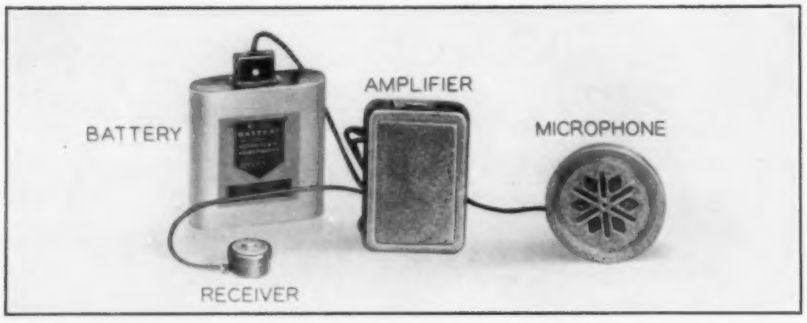


FIG. 3. ABOVE: THE AUDIPHONE OF 1924; BELOW: THE AUDIPHONE OF 1935.

Hearing Aids for the Individual

It is a common experience among deafened people that they hear better over the telephone than when listening directly to some one speaking. The reason is that the telephone amplifies the sound. Early hearing aids were unable to amplify the sound very much so that they were of use to moderately deaf people only. As improved instruments and telephone devices were developed it was only natural that they should find application in hearing aids. It soon became possible to enlarge any sound almost perfectly and in any amount needed. The device, however, might weigh anything from 30 to 200 pounds, as weight was not an important consideration in laboratory research.

The real story of improvement is told when it is stated that from 1924 to 1935 the weight of the Western Electric Audiphone was reduced from eleven pounds to one pound, eight ounces, and from a volume of 1000 cu. in. to something less than 10 cu. in. It is now possible in many instances to conceal completely the fact that an audiphone is being used. This progress is depicted in Fig. 3.

The older microphones used carbon pellets; the newer ones use a very sensitive granular carbon which was developed from research on microphonic materials. The vacuum tube amplifier was replaced by a carbon button amplifier using the sensitive granular carbon. The development of permalloy made possible the construction of a receiver so small that it can be attached to an ear piece fitted into the ear canal. At the same time light-weight batteries, giving an appreciable amount of service, have become available.

Individuals having a moderate degree of impairment, between 35 and 50 db hearing loss, find the combination of microphone and receiver adequate. When the loss is in the range from 50 to 75 db, a carbon button amplifier must be inserted between the microphone and the receiver to further amplify

the sound. The addition of this amplifier increases the weight only 1.5 ounces. When the hearing loss is greater than 75 db, stock audiphones rarely prove satisfactory. Special provisions must be made, depending on each individual case.

The combination of microphone, receiver and rheostat alone is known as the No. 36 Type Audiphone and when used with an amplifier is called the No. 37 or 38 Type. The bone or air conduction receiver may be used with either type. Which receiver is the better in any particular case depends on the kind of hearing impairment. When the deafness is caused by an obstruction in the middle or outer ear the bone conduction receiver may be better than air conduction. When the deafness arises in the inner ear from nerve defects, the air conduction receiver is usually more satisfactory.

Many users of audiphones have considerable difficulty hearing distant sounds, such as are experienced when attending the theatre or seated around a large table. In the early days this was attributed to defects in the audiphone. Today's audiphones reproduce so perfectly that the contention is no longer valid, although the difficulty still persists. The difficulty that the audiphone user has is similar to that experienced by a person with normal hearing when listening with one ear closed. Try this at the theatre some time and note the confusion that appears in the sound. The difficulty may be overcome by using an audiphone for each ear, or binaural hearing as it is called. This enables one to hear sounds in their proper spatial relationships, and much of the confusion in distant sounds is avoided.

Telephone Facilities

For cases of impairment, where the ordinary telephone facilities are not adequate, special provisions are obtainable. Sometimes it is a case of being unable to hear the telephone bell. Lower pitched and more powerful bells and gongs and visual signals are available. When the speech cannot be heard

a special amplifier can be connected into the telephone set. A volume control is provided for the deafened subscriber's use and a switch to remove the amplifier for the normal hearing subscriber.

Hearing Aids for Groups

Hearing aids for installation in churches, theatres and public halls so that a number of persons may listen are also available. These generally take the form of a number of outlets to which either air or bone conduction receivers may be attached. The outlets are connected to a powerful vacuum tube amplifier which in turn is connected to a microphone near the pulpit or stage. This type of aid is generally preferable to listening with an audiphone directly, as the microphone is much nearer the speaker.

Newer Concepts

Research work on hearing is still in progress. One of the important attributes of a sound is its loudness. Methods of measuring loudness have been worked out and have found application in the field of noise measurement. This field has been the subject of study by a committee of the American Standards Association, and many of the methods and techniques worked out in hearing studies have been incorporated in proposed standards for noise measurement.

From loudness level measurements with pure tones of different pitch, contour lines of equal loudness have been mapped out for the entire pitch and intensity range of the normal ear, i.e. the range included between the top and dotted lines on the audiogram chart of Fig. 2. Masking measurements with pure tones indicate how such sounds stimulate the hearing mechanism. The work indicates that when a tone enters the ear it stimulates a certain area in the inner ear. The nerves in the stimulated area conduct impulses to a corresponding area in the brain. The loudness of the sound is correlated with the number of nerve fibres conducting impulses. Since masking

is a measure of the amount of stimulation at various areas in the inner ear, it would be expected that an integration of a masking curve would give the total number of conducting nerve fibres and hence of the loudness of the sound. This has been found to be the case for a number of sounds investigated.

Nerve deafness is supposed to arise from the atrophy of the nerve fibres supplying the various areas of the ear, so that when an area is stimulated there will be less conduction to the brain than in a normal ear. The picture of loudness described above indicates that this loss in conduction will be much more noticeable for faint sounds than for loud sounds. In the latter case there are so many conducting nerves that the loss of a few will be unnoticed. In other words, a person having nerve deafness may show an appreciable hearing loss when tested with sounds that are just audible, but when tested with sounds 30 or more db above audibility will hear in a perfectly normal manner. Obstructive deafness, on the other hand, results in the same hearing loss for faint as for loud sounds. The usefulness of employing loud as well as faint tones in hearing tests, as a means of diagnosing types of deafness, is a subject that needs further study. The complete mapping of the deafened hearing throughout the audible pitch and intensity range may give a clearer insight into the nature of the impairment and the method of relief.

JOHN C. STEINBERG

Communications and Police Protection

EVERY invention, while adding to the comfort or welfare of society, introduces its own peculiar problems. We think of rapid transportation, for example, as a boon to mankind. Primarily, it is; but, at the same time, those who refuse to conform to society's rules of conduct make of it an aid to the law-breaker. The modern criminal employs the speedboat, the airplane, especially the fast motor-car and our hard roads as means to accomplish his own ends. He has greatly shortened the time it takes him to escape from the scene of a crime.

While speed has been added to the kit of the up-to-date criminal, science, fortunately, has been able to answer this speed with more speed. Invention keeps a pace ahead of the enemies of society. The evil-doer knows that, whereas a few years ago half an hour or longer might elapse before a policeman put in his appearance, it is now likely to be a matter of only a few minutes before a dozen or more officers of the law reach the scene. Escape time has been greatly reduced. And this diminution has been brought about chiefly by agencies of communication—the telephone, the teletypewriter and the radio, along with improved techniques for their application to law enforcement.

With time having become so important an element in the apprehension of criminals, it is essential that the public cooperate with police forces in order to secure the maximum of protection. None is more aware of this fact than the police official. Constantly, police departments urge citizens not to delay in reporting to headquarters not only crimes which are witnessed but suspicious persons or circumstances. The New York City Police Department recently distributed 100,000

posters, appealing to the public to "Phone the Police." The faster a report goes in to headquarters, the faster police departments can swing into action, thus cutting down "escape time" and making an arrest more probable.

In general, it may be said that there are three types of police communication. First, there is the telephone. With its 87,000,000 miles of wire, its army of trained, alert workers motivated by the traditional Spirit of Service, the telephone system offers the means of making the quickest possible contact between the public and the police. When you say to the operator "I want a Policeman" you have taken the first necessary step in law enforcement.

To the police forces the telephone is indispensable. Not only do their switchboards handle the many calls from the public but countless messages from one police official to another go over the board.

As the police go into action in the war against crime, not only the telephone but the teletypewriter and the radio come into play. The telephone, the teletypewriter and radio, all three, are swift, practical and dependable; but, the teletypewriter, with its printed record, its duplicate copies, its ability to receive messages at unattended stations, its secrecy and its power to communicate simultaneously with many points over a wide area, offers features of special value to law enforcement bodies, and, accordingly, forms the basic system in a modern police communication network. For establishing contact over a limited area between headquarters and mobile police units, such as automobiles, radio is proving of increasingly great value. Captain Albert B. Moore, Inspector of the New York State Police and Director of the New York State Police School, who is in command of the state police teletypewriter and radio systems, emphasizing the value of these services in a recent talk in Richmond, Va., said:

"Police information to be of value must of necessity be accurate. Any errors in transmission might result in serious com-

plications. The accuracy must be supplemented by rapidity of transmission, and the rapidity of transmission must place the information at all points within a given area simultaneously in order to be of value: Criminals leaving the scene of their operations may depart in one specific direction only to change their course, and perhaps double on their tracks. It is therefore obvious that all directions of the compass must be considered in the hunt for these malefactors. . . .

"Many times I have been asked concerning the value of radio for police work. I believe it is valuable and has its place in any well organized communication system. Radio presents possibilities for limited areas, but in New York state it would be practically impossible to have one radio system capable of reaching throughout the entire state. There are several municipal police stations and these are having highly successful results. However in a broad area, such as New York [state], radio must of necessity be supplemental to teletypewriter."

August Vollmer, criminologist and former president of the International Association of Chiefs of Police, writing (with Alfred E. Parker) on "Crime and the State Police," says of teletypewriter systems and other modern instruments in use by the police: "It is this modern equipment in well-trained hands that often enables the State Police to be so effective against modern criminals. Perhaps this is nowhere so evident as in the use of quick means of communication. . . . The teletypewriter system as installed by the New York State Police is an outstanding achievement in State Police communication."

The best equipped police forces today employ to advantage all three forms of communication.

Teletypewriter Service

Simply expressed, a teletypewriter is an electrical device for typewriting by wire. Perfected in 1915 (when it was known as printing telegraph equipment) it has been continuously improved. Today, including machines for both private lines and

switched service, some 1,200 teletypewriter stations provided exclusively for police purposes are actively in use in the United States. This number is rapidly increasing.

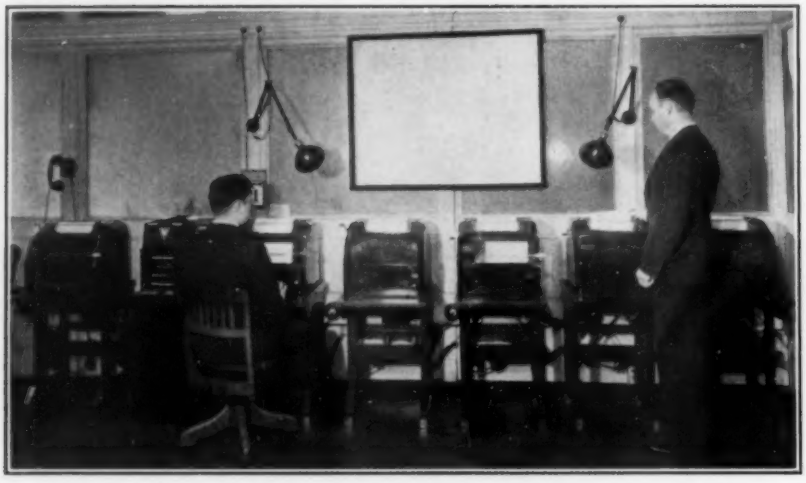
Since 1927, when various municipalities in Connecticut began to use a private line teletypewriter system, the importance of the device in police communication systems has steadily grown. On December 23, 1929, the first state police teletypewriter system was inaugurated by Pennsylvania. On October 1, 1930, New Jersey inaugurated a state-wide system, and provided for the first interstate connection, which was between New York City, New Jersey and Pennsylvania. In 1931 as a demonstration there was established by private wire a police teletypewriter hook-up of 7,000 miles, involving twelve states, a Canadian province and fifteen cities scattered from New York to the Pacific Coast. About a year and a half ago, the state of Connecticut completely revamped its system and established it upon a state basis. In the meantime, a cooperative movement among the states in the east had been growing. The need for rapid communication from one state system to another had become apparent. Out of this need there developed an eight state regional system which furnishes teletypewriter coverage to the states of New Jersey, Pennsylvania, New York, Connecticut, Massachusetts and Rhode Island with connections to Delaware and Ohio.

It is easy to see how lessened has become the chance for the criminal to escape in this large area, for it is possible over the eight state hook-up for a state to flash almost simultaneously a report on a crime to each of its teletypewriter stations and to a police point in a neighboring state, where the report may be retransmitted to other cities and eventually to other states. Full coverage of the eight states for a police alarm is obtained in this way in less than 20 minutes. Furthermore, plans are under consideration for the establishment of teletypewriter systems in a number of adjoining states. When these are connected, as planned, with the existing regional system, there will be no

THE TELETYPEWRITER DIVISION OF THE COMMUNICATIONS SECTION OF THE FEDERAL BUREAU OF INVESTIGATION, UNITED STATES DEPARTMENT OF JUSTICE, WASHINGTON, D. C.

N. Y. DAILY NEWS PHOTO

CAPTAIN ALBERT B. MOORE, COMMUNICATIONS OFFICER OF THE NEW YORK STATE POLICE, ADDRESSING A CONFERENCE OF POLICE OFFICIALS ON TELETYPEWRITER TECHNIQUES. LIEUT. KINSEY OF THE OHIO STATE HIGHWAY PATROL IS PRESIDING.

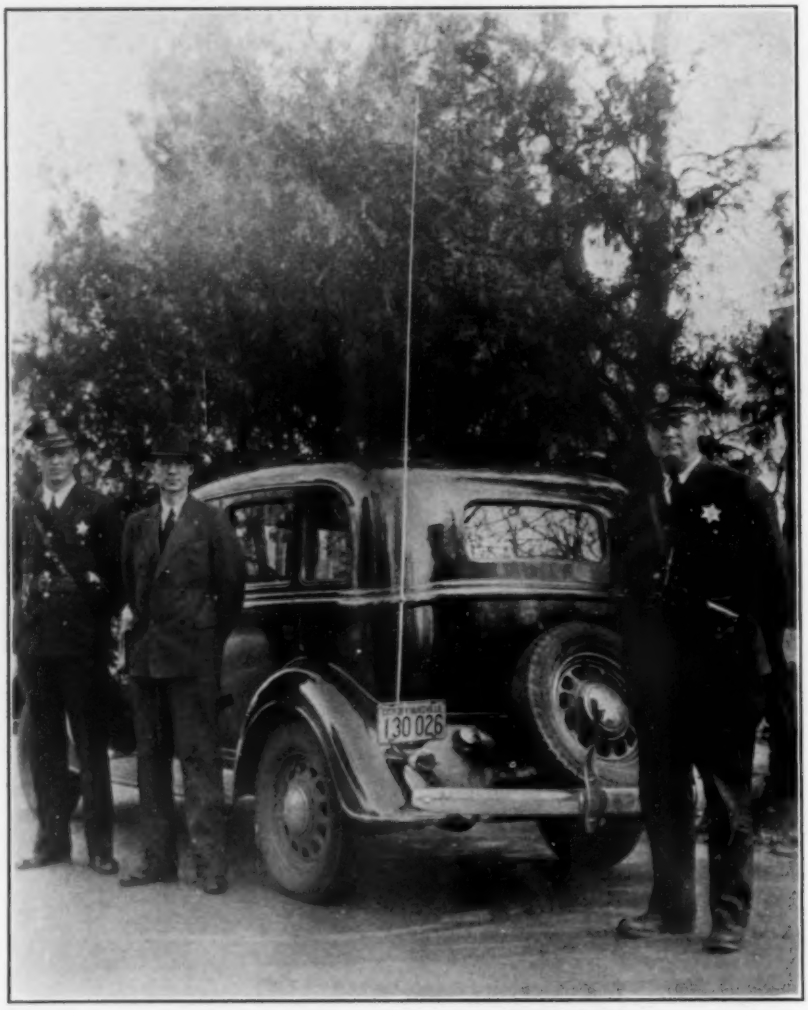


THE NEWARK ZONE HEADQUARTERS OF THE NEW JERSEY STATE-WIDE POLICE TELETYPEWRITER SYSTEM.

THE RADIO ROOM AT POLICE HEADQUARTERS, NEWARK, N. J. THE OFFICER AT THE RIGHT IS RECEIVING A TELEPHONE CALL WHICH REQUIRES THE DISPATCHING OF A RADIO PATROL CAR, THE OFFICER AT THE LEFT IS SELECTING THE CAR, AND THE ANNOUNCER IN THE BOOTH AT THE REAR IS PUTTING THE CALL ON THE AIR.

THE RADIO ANNOUNCER AT NEWARK, N. J., POLICE HEADQUARTERS IS TRANSMITTING AN ALARM OVER THE ULTRA-HIGH-FREQUENCY SYSTEM.

NEWARK POLICE DEMONSTRATING TWO-WAY RADIO OVER THE ULTRA-HIGH-FREQUENCY CHANNEL.



AN EVANSVILLE, IND., POLICE PATROL CAR EQUIPPED WITH THE TWO-WAY ULTRA-HIGH-FREQUENCY RADIO SYSTEM, SHOWING THE TRANSMITTING ANTENNA AT THE REAR OF THE CAR.

longer merely an extensive eastern teletypewriter network but the beginning of a truly national system.

The municipal teletypewriter system may vary from a few sending and receiving machines to the 136 in New York City. The teletypewriter system of the Police Department of the City of New York is, naturally, complex. The greater city is divided into five boroughs—Manhattan, Brooklyn, Bronx, Queens and Richmond. For each borough there is a separate police command with a headquarters office. In each borough headquarters there is a switchboard with tie-lines which permits two-way service between general police headquarters in Manhattan and the other four boroughs. Associated with the switchboards are a total of 136 teletypewriters. This flexible system provides that messages may be sent to any single teletypewriter machine, to a group of machines or to all machines connected with the switchboards; it furnishes two-way communication between general headquarters and the other four borough headquarters, as well as one-way communication between each borough headquarters and each precinct in the borough. Two classes of information are transmitted over the system: first, that of general importance which is transmitted by general headquarters to the other boroughs where it is widely distributed when the precincts are involved; second, that which concerns a particular borough. The information thus transmitted originates from communications received at headquarters from precinct, division or district commands, or from reports from the public.

A good example of a county system is that which serves the police of Nassau County. It is not only useful in the work of protecting all sections of the townships not included within the limits of incorporated villages (in certain instances incorporated villages are patrolled also) but, as it is tied in directly with the New York City police teletypewriter system and the New York State system, it is one unit in a regional network.

The county police department is divided into six precincts

with headquarters at Mineola. The system consists of a 20-line switchboard at Mineola from which two-way circuits are extended to each precinct headquarters, terminating in receiving and sending instruments. The switchboard is so arranged that the operator may send or receive messages to or from any station connected with the switchboard. Messages may also be sent simultaneously to a selected group of stations or to all stations in the system.

With the New York City system, the Nassau County system is connected by two one-way circuits. The circuit from Mineola to New York City terminates in a receiving only machine at Manhattan headquarters, while a circuit from Manhattan headquarters terminates in a receiving only instrument at Mineola.

These municipal and county systems are, generally, connected with each other and with the state systems and are tied in by direct teletypewriter circuits with the systems of neighboring states. In many instances, they are supplemented by strategically located police radio stations.

The state of New York dispatches over its teletypewriter system more than 250,000 communications each year. Of these, about fifty per cent are concerned with automobile registrations and requests for data, stolen cars, recovered cars, hit and run drivers and emergency notices to automobilists. Another ten per cent is accounted for by reports on missing persons, with about forty per cent devoted to the more spectacular misdeeds and routine administrative business. The dramatic crime is relatively rare. Its scarcity may be due somewhat to the preventive factor present in modern police communication systems. Police officials are convinced that the knowledge of the existence of modern communication equipment in a given area acts as a crime deterrent.

The teletypewriter is admirably suited to the handling of that vast amount of police business of which the public does not hear. In many cases, an instrument is stationed in the

state's motor vehicle bureau so that data needed by the police can be obtained promptly and reported back.

Most police teletypewriter systems are set up on a private line basis. However, a certain limited use of Teletypewriter Exchange Service has developed since 1931 when the latter service was introduced.

One of the most interesting of recent installations is that of the Federal Bureau of Investigation of the U. S. Department of Justice. Teletypewriter Exchange Service (familiarly known as TWX) was placed in operation in 1935 for communication between the Bureau's Washington headquarters and its 36 field offices located in other strategic cities throughout the country. There are four machines in the headquarters office at Washington, two each in the New York, Chicago and Philadelphia offices, and one each in the remaining field offices.

When the Bureau's Director, J. Edgar Hoover, or a member of his staff in Washington wants to communicate with the field in which are operating 500 specially trained men—the famous "G-men"—the procedure is somewhat as follows:

In the communications section of the Bureau in Washington, one of the men assigned to the work throws a switch on one of the machines. When the TWX operator indicates that she is ready, the Bureau operator types, let us say, Denver 0711. When, a few moments later, a bell rings in the Denver office there will be some one on duty to handle the call, for all the field offices, in charge of special agents, are open day and night. The field operator establishes connection and the Denver machine is ready to reproduce the message typed in Washington.

Again, Washington may want to be in touch with all 36 field offices at one time. There may even be additional temporary offices with which headquarters wants to communicate while addressing the field. Swiftly, Bell System operators go into action. Following a carefully formulated plan, they set up a conference TWX circuit linking the Washington office, over

hundreds of miles of wire, with every field office. In less than half an hour, every teletypewriter in every field office is simultaneously clicking off the Washington report. The communication may have to do with a matter of administrative routine, with a robbery or a kidnaping, with any one of hundreds of crimes to which the G-men may be assigned.

The Bureau, of course, makes extensive use of the long distance telephone. Its speed, privacy and suitability to personal, two-way discussion commends it. When, in addition to speed, privacy and the two-way channel, it is desirable that the message be transmitted in written form, TWX service efficiently meets the need.

The following actual case is a good example not only of cooperation between different police organizations but of the value of the teletypewriter in spreading information quickly over a wide territory.

Four men broke into a jewelry shop in Beacon, N. Y. Local police surprised the thieves and managed to catch one. The other three escaped in an automobile, taking the road for New York. Immediately a message was dispatched over the state teletypewriter system by the State Police at Fishkill. The robbers were sighted once again on their dash southward and an added alarm was teletyped concerning them. By the time the fleeing thieves reached Yonkers, practically every peace officer in the county and every police officer in New York City was on the lookout for them, having been warned by teletypewriter messages relayed by radio to patrol cars or by telephone to call-boxes.

Charles Smith, Westchester County Parkways patrolman, encountered the robbers in Yonkers. He waved them to a stop but they answered by firing their revolvers at him. Smith gave chase on his motorcycle and forced the speeding car into a ditch.

A hand to hand combat ensued. Smith caught one of the

trio, but the other two broke away and, commandeering a taxi-cab, started once more for New York.

The taxi-cab was halted finally by New York City police. Once more there was an exchange of revolver shots. This time the police killed both the bandits.

Another actual case, in which telephone, teletypewriter and radio dove-tailed, is that of Robert J. Mahoney who shot State Trooper George Doring in Sudbury, Mass. Five hours later, Mahoney was dead in Leicester, Mass. Trooper James H. O'Neill had brought him down.

Trooper Doring had called on Mahoney to halt. Mahoney replied by firing at him and wounding him. The gunman, a girl beside him in his car, roared down the road toward Worcester.

"Within five minutes after the shooting of the policeman," said the *Worcester Telegram*, "the Framingham barracks of the state police had established contact with troopers on patrol. Two men were assigned to watch the Post road and question all persons answering the description given. One trooper was posted near the scene of the attack. . . . Garages and call stations were notified to flag all the passing troopers and to direct them to call in immediately.

"Automobiles equipped with radio receiving sets were immediately contacted as they cruised through the Lake Boone region. Those troopers learned of the crime within ten minutes of its occurrence.

"The teletype switch was thrown open and a white light glowed over 'Framingham' on the switchboard in the State House headquarters of the State police patrol. An operator pulled a switch on the teletype machine and a policeman in the Framingham barracks began his story. The story was in cold type almost as soon as one could tell it. The operators threw down the plugs to Holden, Middleboro and Northampton. Over the wires to these stations went the news of the shooting.

"At Framingham the telephones rang loudly as the troopers called in from garages and call stations. Nine men were ordered to Worcester to find the missing bandit and bring him back. They started for Worcester while 23 men whirled out of the substations at Reading, Concord, Topsfield and Wrentham. . . . In the meantime at Holden the teletype was grinding out its story."

From the north, east, west and south the troopers came, called by the teletypewriter, telephone and radio. Finally, a hundred men were involved in the hunt. The bandit was bottled up somewhere near Worcester. Every avenue of escape was closed. It was only a matter of time before Mahoney was caught.

At Spencer the engulfing waves of troopers met. Mahoney was surrounded. He wrecked his car against a stone wall, injuring his girl companion, and took to the woods, alone and on foot. He ducked and dodged. He tried to steal a truck and failed. From another truck he got a short ride. At Leicester, he was on foot again, crawling through back-yards. He climbed the fence at the Leicester Tavern. Trooper O'Neill of Holden saw him. He called to him, then fired. Mahoney toppled. O'Neill went after him. Lieutenant Shimkus and Sergeant Sullivan ran up. Mahoney had crawled to a cellar, leaving a trail of blood. Shimkus called on him to surrender. The bandit, his voice choking, refused and fired at the officer. The Lieutenant rushed upon him and disarmed him. Mahoney lost consciousness and died half an hour later.

In the words of the *Worcester Telegram:* "A bullet killed him, but radio and teletype and telephone had already doomed him."

Since 1921, when the Detroit Police Department began its experiments, an increasing number of law enforcement units have been making use of radio. At the close of 1935 there were in operation more than 60 city, county and state Western Electric Police Radio Systems, as well as others manufactured by other companies, all of them getting cars full of police officers to scenes of crime within two or three minutes after the report had been received at headquarters. Police radio is giving added protection to 35 million people.

Two-Way Police Radio

In the spring of the same year, Bell System engineers contributed to the war against crime one more important weapon. This is a Two-Way Police Radio, a great advantage to peace officers in a limited area. With this equipment, the motor patrolman not only receives alarms but he may acknowledge them, request further instructions, report crimes or suspicious persons or circumstances, may inform headquarters of his position and progress on an assignment—all, without leaving the wheel of his car.

The first installation of the new system was in Evansville, Indiana. Westfield, N. J., Morristown, N. J., Manchester, N. H., Elgin, Ill., Wheeling, W. Va., and Nashville, Tenn., are scheduled to have two-way equipment in operation in the near future.

Statistics covering five months of operation in Evansville are startling. They reveal a decrease in crimes of 17 per cent and an increase in arrests of 60 per cent, following the introduction first of one-way and later of two-way police radio.

The two-way system operates on ultra-high frequencies in the band of 30–42 megacycles. In addition to a transmitter at headquarters and receivers in the patrol cars, it includes specially designed transmitters for the cars and a receiver at headquarters. The car transmitters, weighing only 20 pounds, are only 11 by 7 by 6½ inches in size and yet are held to within .025 of an assigned frequency by a new type of crystal with a low temperature coefficient.

A flexible steel rod, projecting slightly above the top of the car, acts as a vertical antenna which transmits as well as receives. On the dashboard hangs a telephone, much like the familiar hand-set, and the patrolman's voice speaking through it operates relays which put the car transmitter on the air. These relays are so timed that they do not switch off during intervals between words but do so after the brief pause which

shows that the speaker has finished. The car receiver then automatically goes into operation and is ready to pick up messages from headquarters.

Most police radios operate on a medium frequency band, roughly from 1,600 to 1,700 kilocycles and from 2,300 to 2,500 kilocycles. With an eye to the crowding that might take place within that narrow range, the Federal Communications Commission recently assigned to police work experimentally, an additional band which ranges from 30,000 to 42,000 kilocycles. The system of the Police Department of the City of Newark, N. J., among the most up-to-date one-way installations in present use, operates in the new high frequency band on 30,100 kilocycles.

For municipal stations, there are certain advantages in ultra-high frequency operation. Freedom from atmospheric disturbances is one. No static, or thunderstorms will trouble the ears of the motor patrolmen.

As wave length determines antenna length, Newark is able to employ a short section on the 100 foot flag pole atop the city's tallest building, the National Newark & Essex Bank Building. Conversion to two-way service would, should authorities determine upon it, be very simple as the car transmitters could operate on the wave length which the station now uses. Short waves do not carry great distances from such stations. For State Police work two-way radio, because of limited range, is not now developed so as to be practical. The limited range has an advantage, however, in that a city as close to Newark as Albany probably could use the same wave length without overlapping. However, as the separation between ultra-high frequency channels is very narrow all apparatus, to perform successfully, must be of great refinement, stability, selectivity and reliability.

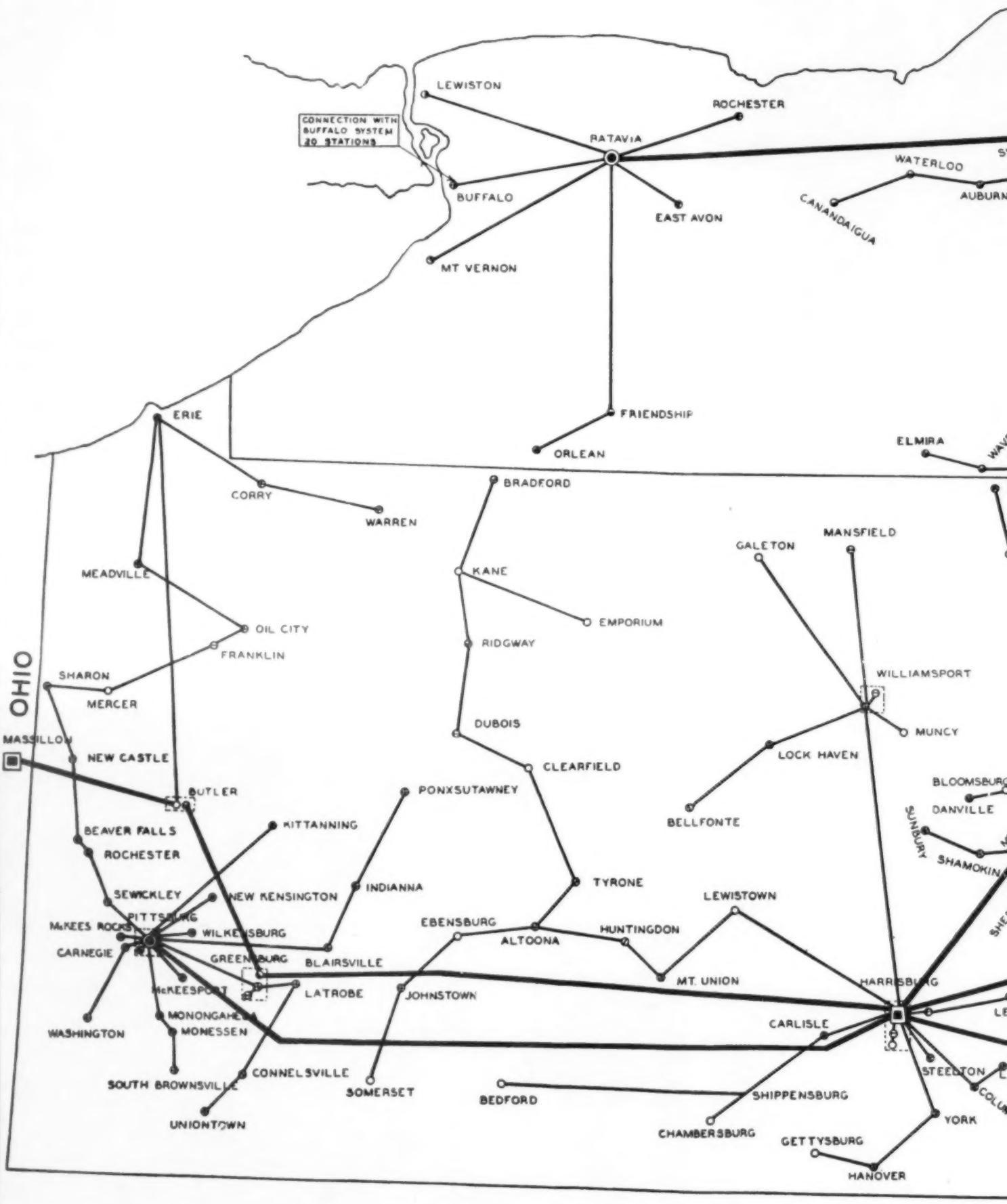
Put into service on October 3, 1934, by Director of Public Safety Michael P. Duffy, the radio branch of the Newark Police Department has made enviable records not only in efficient

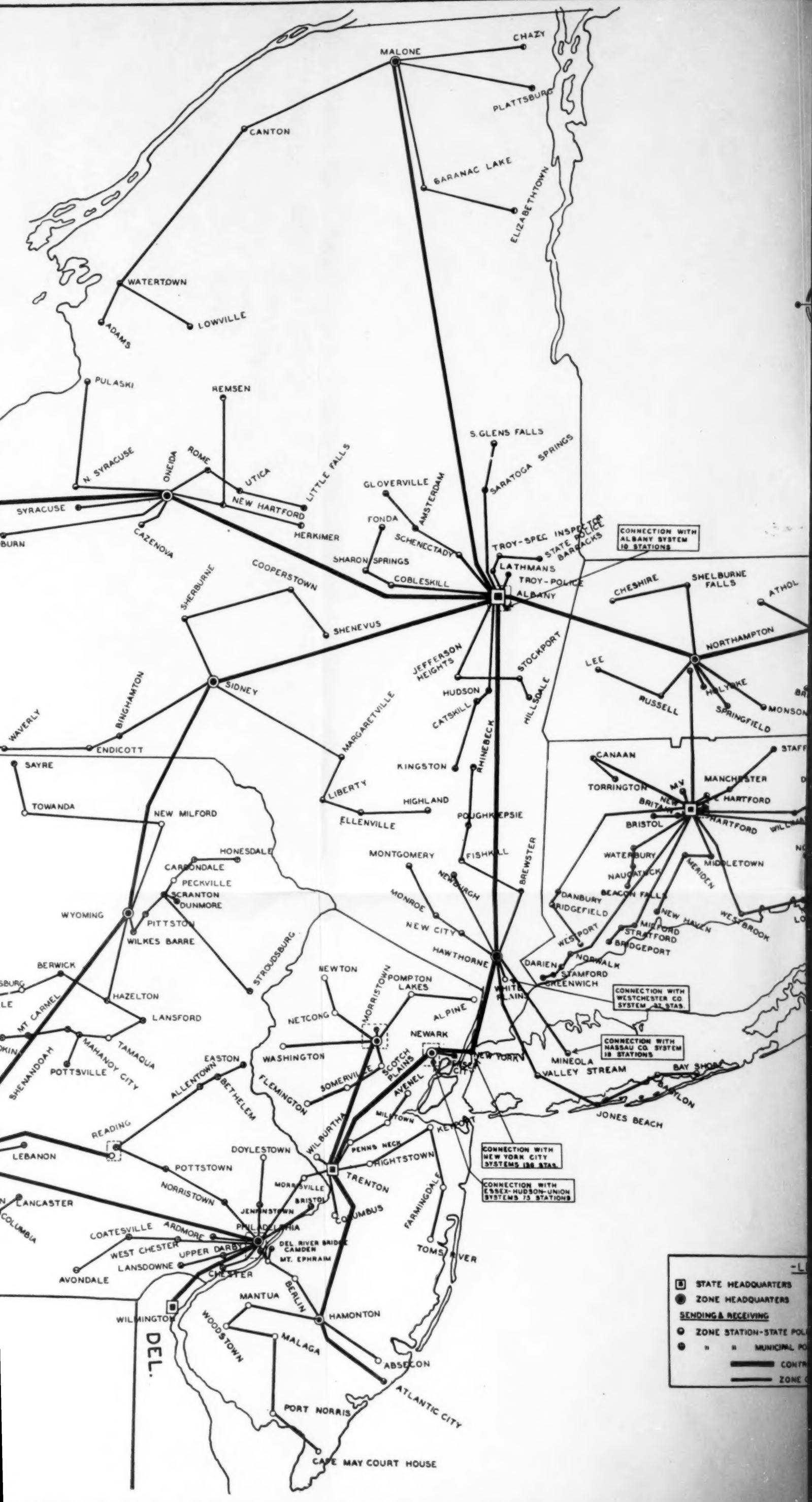
POLICE TELETYPEWRITER SYSTEM

CONNECTICUT–MASSACHUSETTS–NEW JERSEY

NEW YORK–PENNSYLVANIA–RHODE ISLAND

WITH CONNECTIONS TO DELAWARE AND OHIO



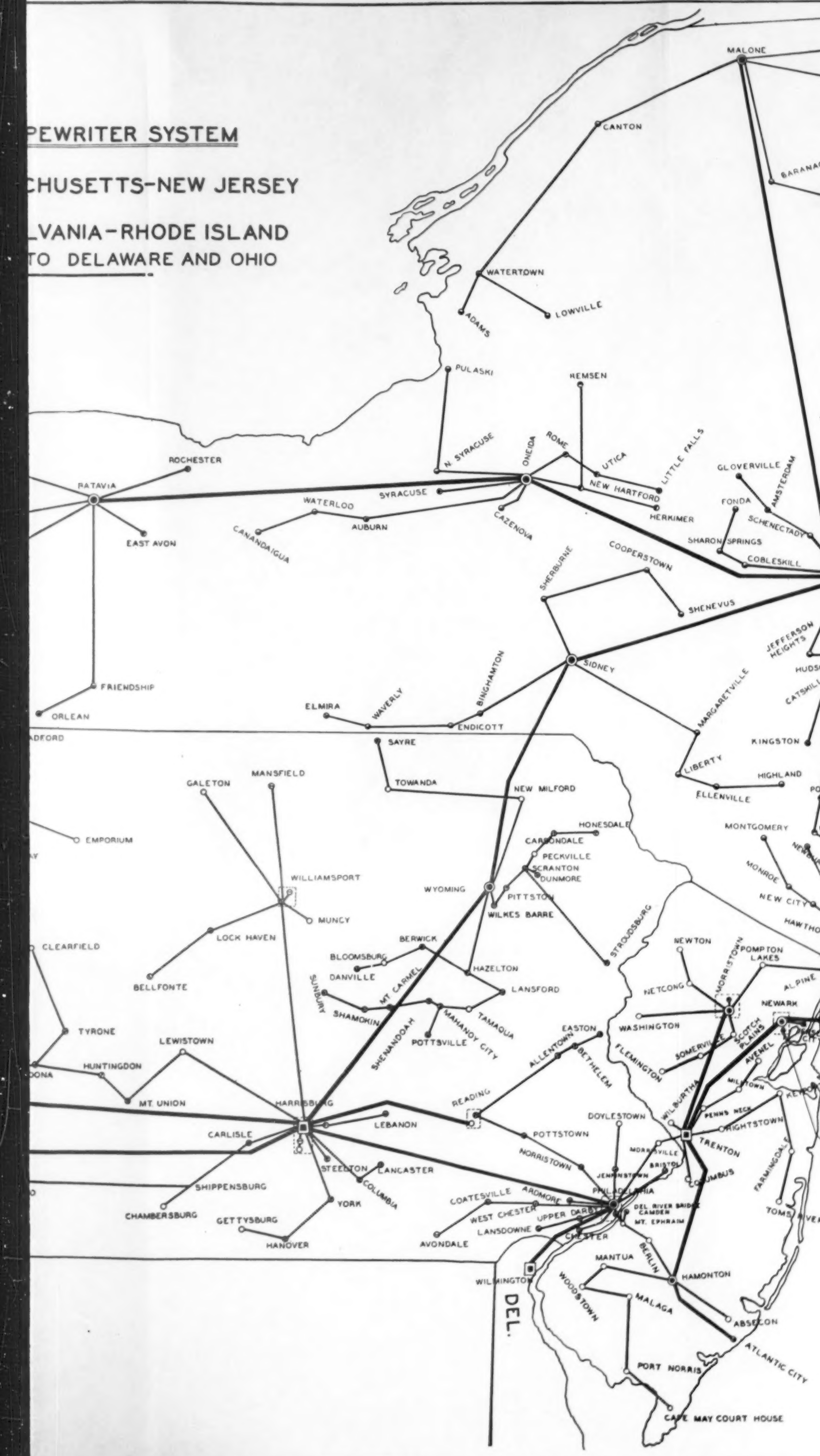

MALONE
CHAZY
PLATTSBURG
CANTON
BARANAC LAKE
ELIZABETHTOWN
WATERTOWN
LOWVILLE
ADAMS
PULASKI
REMSEN
N. SYRACUSE
ONEIDA
ROME
UTICA
LITTLE FALLS
NEW HARTFORD
HERKIMER
SYRACUSE
CAZENOVIA
S. GLENS FALLS
SARATOGA SPRINGS
GLOVERVILLE
AMSTERDAM
FONDA
SCHENECTADY
SHARON SPRINGS
COBLESKILL
TROY-SPEC INSPECTOR
STATE POLICE BARRACKS
LATHMANS
TROY-POLICE
ALBANY
CONNECTION WITH ALBANY SYSTEM 10 STATIONS
SHERBURNE
COOPERSTOWN
SHENEVUS
CHESHIRE
SHELBURNE FALLS
ATHOL
NORTHAMPTON
JEFFERSON HEIGHTS
STOCKPORT
HUDSON
CATSKILL
HILLSDALE
LEE
RUSSELL
HOLYOKE
SPRINGFIELD
MONSON
SIDNEY
BINGHAMTON
WAVERLY
ENDICOTT
MARGARETVILLE
KINGSTON
RHINEBECK
LIBERTY
HIGHLAND
ELLENVILLE
POUGHKEEPSIE
CANAAN
TORRINGTON
MANCHESTER
HARTFORD
NEW BRITAIN
BRISTOL
SAYRE
TOWANDA
NEW MILFORD
HONESDALE
CARBONDALE
PECKVILLE
SCRANTON
DUNMORE
WYOMING
PITTSTON
WILKES BARRE
STROUDSBURG
MONTGOMERY
FISHKILL
BREWSTER
NEWBURGH
MONROE
NEW CITY
HAWTHORNE
WATERBURY
MERIDEN
MIDDLETOWN
NAUGATUCK
BEACON FALLS
DANBURY
BRIDGEFIELD
NEW HAVEN
WEST BROOK
MILFORD
STRATFORD
BRIDGEPORT
WESTPORT
DARIEN
NORWALK
STAMFORD
GREENWICH
WHITE PLAINS
CONNECTION WITH WESTCHESTER CO SYSTEM 32 STAS.
CONNECTION WITH NASSAU CO. SYSTEM 18 STATIONS
MINEOLA
VALLEY STREAM
BAY SHORE
BABYLON
JONES BEACH
BERWICK
HAZELTON
LANSFORD
MT. CARMEL
SHENANDOAH
POTTSVILLE
MAHANOY CITY
TAMAQUA
NEWTON
POMPTON LAKES
MORRISTOWN
NETCONG
ALPINE
NEWARK
WASHINGTON
SOMERVILLE
SCOTCH PLAINS
AVENEL
PERTH AMBOY
NEW YORK
EASTON
ALLENTOWN
BETHLEHEM
FLEMINGTON
READING
LEBANON
POTTSTOWN
NORRISTOWN
DOYLESTOWN
WILBURTHA
MILLTOWN
PENNS NECK
HIGHTSTOWN
TRENTON
KEYPORT
CONNECTION WITH NEW YORK CITY SYSTEMS 136 STAS.
CONNECTION WITH ESSEX-HUDSON-UNION SYSTEMS 75 STATIONS
MORRISVILLE
BRISTOL
COLUMBUS
FARMINGDALE
TOMS RIVER
LANCASTER
COLUMBIA
JENKINTOWN
PHILADELPHIA
COATESVILLE
ARDMORE
WEST CHESTER
UPPER DARBY
LANSDOWNE
AVONDALE
CHESTER
DEL RIVER BRIDGE CAMDEN
MT. EPHRAIM
WILMINGTON
MANTUA
BERLIN
HAMONTON
WOODSTOWN
MALAGA
ABSECON
ATLANTIC CITY
PORT NORRIS
CAPE MAY COURT HOUSE
DEL.
STATE HEADQUARTERS
ZONE HEADQUARTERS
SENDING & RECEIVING
ZONE STATION-STATE POL
" " MUNICIPAL PO
CONTR
ZONE

PEWRITER SYSTEM

CHUSETTS-NEW JERSEY

LVANIA-RHODE ISLAND

TO DELAWARE AND OHIO



CHAZY

PLATTSBURG

RANAC LAKE

ELIZABETHTOWN

STATE POLICE RELAY POINT TO THE FOLLOWING POLICE DEPTS

ARLINGTON
BELMONT
BOSTON POLICE HDQRTS. WITH SECOND MACHINE ON SEPARATE BOSTON POLICE DEPT SYSTEM SERVING 10 DIVISION STATIONS
BOSTON CRAIGIE BRIDGE - M D C
BRIGHTON SPEEDWAY - CHARLES RIVER - M D C
BROOKLINE
CAMBRIDGE
CHELSEA
COHASSET
DEDHAM
EVERETT
HULL - SUMMER
LYNN
MALDEN
MEDFORD
MEDFORD - MIDDLESEX FELLS - M D C
MELROSE
MILTON
MILTON - BLUE HILLS - M D C
NEEDHAM
NEWTON
NORWOOD
QUINCY
READING
REVERE
REVERE BEACH - M D C
SAUGUS
SOMERVILLE
SWAMPSCOTT
WALTHAM
WATERTOWN
WELLESLEY
WEYMOUT
MASS MOTOR VEHICLE DEPT
MASS BOARD OF PROBATION

S. GLENS FALLS

SARATOGA SPRINGS

TROY - SPEC INSPECTOR

STATE POLICE BARRACKS

CONNECTION WITH ALBANY SYSTEM 10 STATIONS

LATHMANS

TROY - POLICE

ALBANY

CHESHIRE

SHELBURNE FALLS

ATHOL

LUNENBURG

CONCORD

ANDOVER

SALISBURY

TOPSFIELD

BOSTON

NORTHAMPTON

LEE

STOCKPORT

HUDSON

RHINEBECK

HILLSDALE

RUSSELL

HOLYOKE

SPRINGFIELD

MONSON

HOLDEN

WORCESTER

GRAFTON

BROOKFIELD

FRAMINGHAM

FOXBORO

NORWELL

W BRIDGEWATER

WAREHAM

FALL RIVER

HYANNIS

CANAAN

STAFFORD

TORRINGTON

MANCHESTER

DANIELSON

HARTFORD

BRISTOL

WILLIMANTIC

POUGHKEEPSIE

FISHKILL

BREWSTER

WATERBURY

MIDDLETOWN

NORWICH

HAUGATUCK

MERIDEN

GROTON

DANBURY

BEACON FALLS

RIDGEFIELD

NEW HAVEN

WEST BROOK

NEW LONDON

WESTERLY

NEWPORT

NARRAGANSETT

WESTPORT

MILFORD

STRATFORD

BRIDGEPORT

DARIEN

NORWALK

STAMFORD

GREENWICH

WHITE PLAINS

CONNECTION WITH WESTCHESTER CO SYSTEM 42 STAS

CONNECTION WITH NASSAU CO SYSTEM 18 STATIONS

MINEOLA

VALLEY STREAM

BAY SHORE

BABYLON

JONES BEACH

CONNECTION WITH NEW YORK CITY SYSTEMS 136 STAS.

CONNECTION WITH ESSER-HUDSON-UNION SYSTEMS 75 STATIONS

-LEGEND-

STATE HEADQUARTERS
ZONE HEADQUARTERS

SENDING & RECEIVING
ZONE STATION - STATE POLICE
" " MUNICIPAL POLICE

RECEIVING ONLY
STATE POLICE STATION
HIGHWAY PATROL STATION
MUNICIPAL POLICE STATION

CONTROL POINT CONNECTING CIRCUITS
ZONE CIRCUITS

7-1-36

GENERAL COMMERCIAL AGENT
COMMUNICATION SURVEYS
NEW ENGLAND TEL. & TEL. CO.

law enforcement but in overhead cost reduction. Said the *Newark Ledger* recently:

"The radio division has made 849 arrests, extinguished 55 fires, saved more than 40 lives and recovered stolen property valued at $115,002. . . .

"In 1931 there were 110 more men in the police department than there are today. Radio made it unnecessary to replace them upon retirement. Figuring on a base pay of $2,300, saving of their salaries means more than $250,000 in the annual running expense of the police division.

"In addition Duffy was able, due to the wide scope that one car can handle, to abandon four police precincts.

"Several months ago, the director shut down the Fifth, Sixth, Seventh and Eighth Precinct Station houses. 'These properties will be put on sale when the real estate market improves,' Duffy said.

"'That means the property will once more become taxable and will show in the ratables.'

"Case records kept by the radio division tell an interesting, important tale.

"'On Nov. 8 at 1:44 P.M., car 42 was sent to 52 Littleton Avenue, where a thief was ransacking the premises. The house was covered front and rear and a radio patrolman entered the front door and arrested the burglar. At 1:48 P.M., a patrol wagon was summoned to take the prisoner. The man has a criminal record.'

"'On Dec. 11 at 10:15 A.M., car 52 noticed smoke coming from a house on North Seventh St. A patrolman entered the building and brought a 90-year-old man and an infant to the street in safety. In doing so he was overcome by smoke and received treatment at City Hospital.'

"'On Dec. 6 at 11:43 P.M., two cars were sent to a Sumner Avenue building where a woman was about to commit suicide by leaping from the roof. Car 22 arrived at 11:45 P.M. and took her from the roof in safety.'

"'On Nov. 18, radio car 52 noticed auto parked near Bloomfield city line. Two men were in car. Officers investigated and found car contained sawed-off shotgun, an automatic revolver, and burglar tools. The men admitted a plan to hold up a gas station.'

"These are only a few of the tasks the radio men have performed successfully."

A review of recent developments in methods of exchanging intelligence among law enforcement units, indicates that to

the constant war against crime the art of communication has made two most valuable contributions. First, through virtually universal telephone service it enables the public quickly to give an alarm. Second, through teletypewriter and radio it allows the authorities to take rapid action upon the receipt of the alarm and, if need be, to spread information far and wide with little or no loss of time.

To the long arm of the law has been added a voice. And that voice, whether it be the 24-hour a day chattering of the teletypewriter, the staccato bark of the radio or the familiar ring of the telephone, is daily putting fear into the hearts of criminals and making life safer for the public.

STERLING PATTERSON

Engineering the Telephone Fleet

WITH a fleet of some 17,000 cars and trucks in service throughout the country, the Bell System requires annually a large number of motor vehicles for replacements alone. While full advantage is taken of advances in design which are developed within the automotive industry, the great majority of bodies and associated equipment for the vehicles purchased are designed by Bell System engineers. In this large portion of the fleet are the vehicles ranging in capacities from one-half ton to 10 tons which transport workmen as incidental to their general functions of gang construction and maintenance work.

As the first step in providing proper vehicles for telephone work in either the commercially available or specialized group, chassis are selected for each individual kind of service, with regard to carrying capacity, performance characteristics, and size. In addition, consideration is given to the first cost and the economy of operation of the chassis as well as service facilities available. This carefully selected type of chassis, which is ordinarily built in quantity and thus can be secured at a reasonable price, is the foundation for the proposed unit of the telephone fleet. A satisfactory type of chassis is usually available in more than one make, so that there is provided a choice in various parts of the country to meet local conditions of service.

For the cases where special body equipment is required, there is at the present time a sufficient standardization of chassis dimensions so that one design of body can be made which can be adapted, with minor modifications, to several makes of chassis.

The vehicle manufacturers generally have developed cabs which fit their chassis and are suitable for use with practically

any type of body that it may be desired to mount back of them. These cabs also are produced in quantity at very reasonable prices.

Having secured the chassis and cab suitable for the job in question, a specially adapted body, together with accessory power devices and other equipment applicable to the particular type of work, are added to provide the complete telephone vehicle. Depending upon the class of work, the accessory equipment may include such items as a power winch, pole derrick, collapsible power reel, power pump, air compressor, towing hook, etc. It is the purpose of this paper to discuss some of the factors entering into the design of various types of telephone truck bodies. The accessory power equipment will not be discussed in detail.

In the work of the telephone engineers, first consideration is always given to factors of utility, cost, maintenance, and safety, while adding, in so far as practicable, features which have to do more with appearance. Much has been accomplished by the manufacturers in providing lower chassis designs, with greatly improved radiator, lamp, hood, cowl, and cab appearance, as compared with those available a few years ago. While holding fast to maximum utility, the appearance of the telephone body designs has kept in step with the rapid improvements which have been made throughout the automotive industry.

One of the generally used units in telephone service is the one-half-ton installation car, in the "LI" classification, which serves the installers and their helpers in connecting, moving, and removing the telephone sets and the associated wire to and upon the subscribers' premises. At the present rate of about 1,300 LI bodies purchased a year, the production has reached sufficient quantities to warrant the use of such manufacturing equipment as to result in low cost, high quality, and uniformity in the units.

For these and most of the other bodies which are fabricated from sheet metal, a type of sheet is used which is protected

from rusting by very thin smooth coats of zinc forming what is termed a galvannealed surface. With such material, even though the paint on the outside of the body is ruptured, there is very little tendency for rust to form and undermine the adjacent painted surfaces. Thus the galvannealed material improves the appearance and increases the life of the body.

The roof, drawers, doors and various other parts of the body are formed in large presses with suitable dies and jigs, to expedite the work and to insure good fits between fabricated parts as well as between drawers and their guides. Throughout the construction, spot welding is used very generally, with only a small number of rivets at strategic locations.

Strong ladder brackets are provided for use at the side of the LI body to carry the extension ladders which are ordinarily used by installers. Quick-acting fasteners are used to secure the ladders in place while in transit.

Practically every item of equipment, both tools and materials, which an installer ordinarily uses is assigned its properly located compartment in the body. Provision is made for carrying all sizes and types of telephone instruments and subscriber sets in such a manner that they are easily placed in and removed from the body and so that they will not be damaged in transportation even though in isolated cases particular instruments may be carried several days. The materials are so arranged in the body that those which are associated are grouped together and those most frequently used are most readily accessible. Some idea of the amount of detail represented in the design of the body is obtained when it is realized that in this one body there are incorporated about 125 drawer spaces, racks, tool holders, and compartments. All of the items of equipment are carried, protected from the weather, in these conveniently accessible compartments, in a body which is quite low in price for the facilities provided. The entire unit is painted in the standard telephone color, providing a very presentable type of vehicle for the use of the thousands of Bell

System installers in their very large number of customer contacts.

There are other types of bodies having somewhat the same general appearance as the LI installation body just mentioned, but which are necessarily entirely different in compartment space and interior design to adapt them to other classes of service. One such unit is known as the "Type SL" body, for use of section linemen and installer-repairmen. In addition to the suitable compartment spaces within the body, this unit has a strongly built roof with sides and a front rail and also rope loops, providing facilities for carrying brush during tree trimming work, or bulky materials which might be required in connection with repair work. Also, a unit of this type equipped with a light towing hook at the rear can be used where desired in isolated territories to haul light trailers carrying poles or coils of wire.

Yet another vehicle of the general type of the LI unit is the splicer-repairman body, which is known as the "CS" unit. Because of the volume of tools and equipment required by this type of gang, the CS body is larger than either of the two previously mentioned. The weight of materials and tools, such as tanks of nitrogen gas and lead sleeves, which have to be carried, is so great that in order to keep within the normal carrying capacity of light commercial chassis, it has been found desirable to fabricate the body and its equipment from a very light aluminum alloy. By so doing, several hundred pounds in weight are saved as compared with similar steel bodies, which, of course, can be added to the net pay load. It may be of interest to note that when this body was designed, it was evident that, in order to make its manufacture practicable, it would be very desirable to fabricate the material by spot welding the aluminum alloy parts rather than by riveting them. In order to make this possible, it was necessary for the body builders to inaugurate new manufacturing practices and provide suitable welding equipment. After some experimenting

and testing, this new practice is working out very satisfactorily. Arc and gas welding were tried, but spot welding was found to be far superior for this work because of the better control of the welding heat.

While the use of aluminum in the body adds approximately 50 per cent to the cost of the finished product, there will be a somewhat greater recovery value when the units are finally disposed of. The use of a lighter, less expensive chassis is permitted. The aluminum alloy provides a painting surface which is free from rust chipping, similar to the result obtained with galvannealed steel surfaces.

As another general type of body design, in some cases very satisfactory results have been obtained through using light commercial panel trucks carrying specially designed inside equipment, as in the installer-repairman units known as the "RI" bodies. In order to add as little as possible to the weight of the panel bodies, which in themselves are rather heavy, and thus provide the maximum carrying capacity, the interior work, which of necessity is quite extensive, is made of aluminum alloy. In so far as practicable, identical units such as the instrument carrying trays are used in the RI, SL, and LI bodies in order to increase quantity production and reduce the cost of these units.

For a single repairman who has to do a considerable amount of traveling in connection with his work, and requires only a limited quantity of tools and supplies, a "Type R" unit is used. This consists of a business coupé having compartments, shelves, drawers, etc., specially adapted for carrying the required materials and tools, and fitted into the generous rear deck of the modern coupé. As with the LI, SL, CS and RI bodies already mentioned, the type R units are equipped with facilities for carrying an extension ladder clamped in supports at the side of the body.

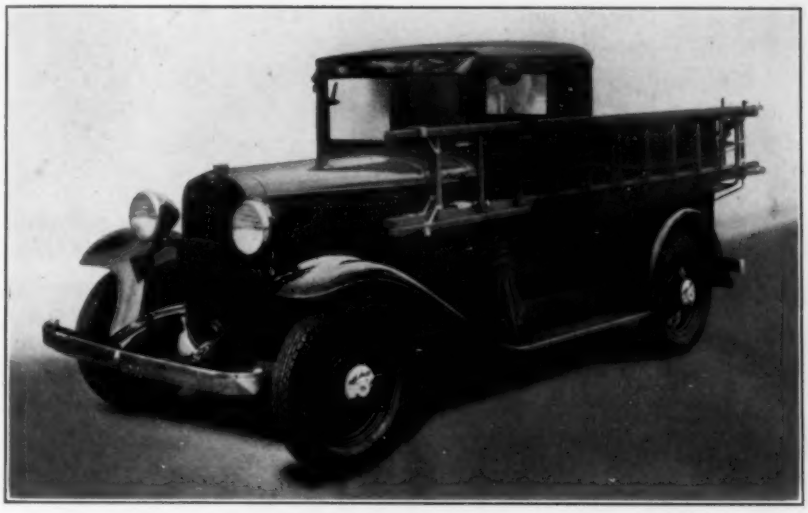
Advancing now to the heavier duty trucks, a broadly used type is represented by the new light pole line and cable con-

struction and maintenance unit of the "LCW" classification. This unit represents the latest development in its class. It is now undergoing field trials and will very soon be available for all Bell System Companies. The LCW unit is designed for the purpose of providing all of the desirable auxiliary power equipment, as well as many other facilities which are outlined below. By utilizing low priced, large production 1½-ton chassis and designing the bodies and other equipment to correspond, it has been possible to make available small gang trucks which have extreme flexibility, and are especially well adapted to the work, at a very low first cost and operating cost per unit.

The LCW bodies are built almost entirely of galvannealed steel, of gauges as light as practicable for various parts of the units. In the construction, welding is used extensively. However, the body is so designed that, if it is necessary to ship it some distance from the point of manufacture, it can readily be disassembled into five parts, packed into a relatively small space and shipped, and then reassembled without difficulty.

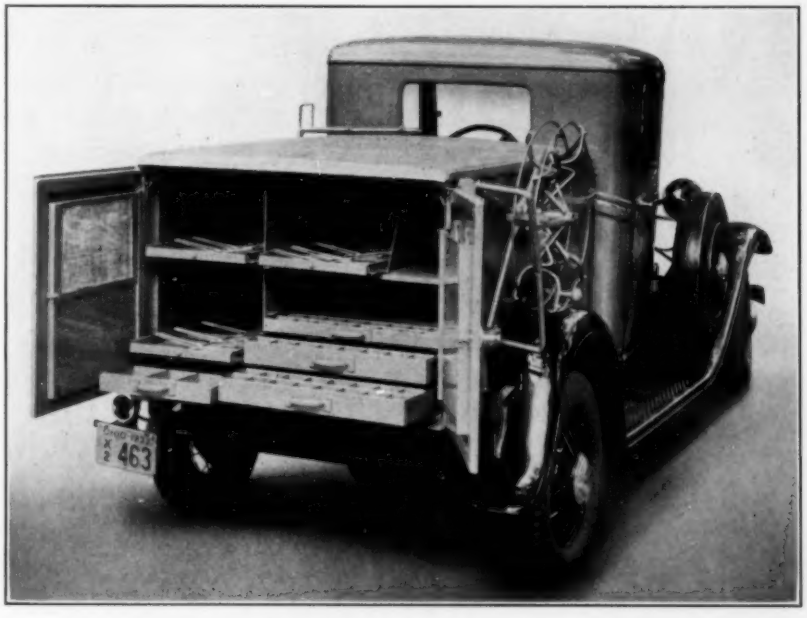
In the design of this body, special attention is given to mounting the power equipment conveniently for use and also for carrying when not in service. For instance, a hinged steel seat covers the power winch, which is located at the forward end of the body just back of the cab. When the winch is not in service, this cover, with its sponge rubber cushion, provides a comfortable seat for those of the gang who are not accommodated in the cab. The seat can easily be hinged together into a flat section and raised above and to one side, leaving free access to the winch for pole derrick work, cable pulling, etc.

When the winch seat is down, the front of the body is entirely sealed against wind and weather, as are both sides and the top, so that the men riding upon the winch seat, as well as the blocks and tackle, etc., are well protected. As a new feature of considerable convenience, the roof on the LCW bodies is of a telescoping type, so designed that it can readily be



THE LI TYPE VEHICLE.

This half-ton truck serves installers and their helpers.



REAR VIEW OF THE LI BODY.

About 1,300 of these bodies are purchased annually.

THE SL TYPE VEHICLE.

This truck is used by section linemen and installer-repairmen.

REAR VIEW OF THE SL BODY.

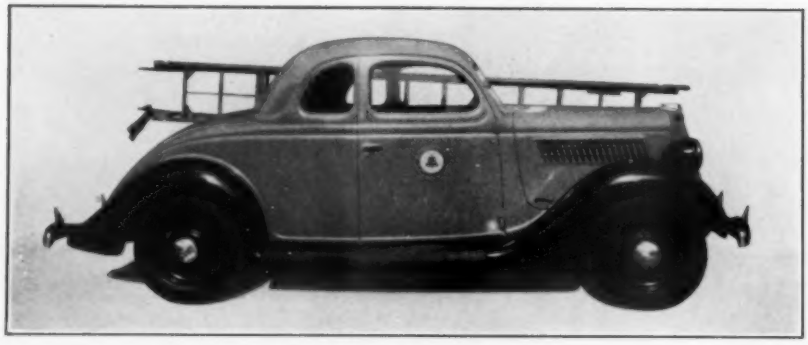
The roof is designed for carrying brush, or bulky materials used in repair work.

THE RI TYPE VEHICLE.

A commercial panel truck, used by installer-repairmen, with specially designed interior fittings.

REAR VIEW OF THE RI BODY.

To save weight for pay load, these interior fittings are of aluminum alloy.



THE R TYPE VEHICLE.

Used by the single repairman who has to cover considerable territory.

REAR VIEW OF THE R BODY.

Specially designed compartments, etc., fit in the coupé's rear deck.

pulled back to cover two-thirds of the entire body or, when the roof is not desired, can be telescoped into a conveniently small space over the front of the unit. The steel plate floor of the body is of diamond grid design so that it presents a good non-skid surface.

As a first step in the design, representative lists of tools and materials to be carried by gangs of this type were studied carefully; then the side boxes, racks, compartments, shelves and partitions were so designed as to carry the proper amount of each class of equipment in a convenient, orderly manner. This consideration is very important, particularly in a truck of this type where the carrying capacity is limited. The proper arrangement and size of carrying spaces permits a quick visual inventory of the materials and tools on the truck, thus obviating an overstock and overweight of some types of equipment and an undersupply of others.

Suitable lockers are provided for carrying the men's extra clothing and their lunches. Also, as a safety precaution, it should be noted that the facilities for carrying linemen's climbers, body belts and safety straps are such as to prevent damage to the leather by the climber gaffs. The various side- and under-boxes of the body can be secured with flush locks when desired.

It is both interesting and surprising to note the great diversity and volume of construction and maintenance work that can be done with these inexpensive 1½-ton truck units. These small gangs operate in a field which in the past has been served by much heavier and more expensive equipment, ranging in size up to five tons' capacity.

The old time, heavy duty construction and maintenance units are rapidly being superseded by lighter types such as the LCW unit and the medium duty outfits represented by the "MC" trucks. The design and functioning of the MC truck is quite similar to that of the LCW. However, the body is somewhat larger, heavier, and correspondingly more expensive, in order

to fit it for use with medium sized gangs operating with 2- to 2½-ton trucks.

In connection with construction work where there is a considerable amount of pole setting to be done, the earth boring machine units are applicable. The body design for such trucks is necessarily different from that of the LCW and MC outfits. The earth boring machine truck bodies, known as "EB" units, must be very strong, particularly in the rear, to handle the severe strains transmitted to them during the earth boring operation. The tools and materials carried on the earth boring machine truck are less extensive in number and volume than on some of the other vehicles; less side-box space and less rearranging of the space are required in order to fit the particular items.

In this body, as in the LCW and MC units, the overhang back of the rear axle is limited because of the necessity of providing adequate stability. For instance, in lifting an auger filled with dirt out of a wet clay hole, the suction is so great that if there were excessive overhang back of the rear axle, the front end of the truck might be lifted off the ground. A somewhat similar condition exists in handling the pole derricks on all types of construction and maintenance bodies. These trucks are supplied with small pole derrick support members which transmit the loads to the ground under the rearmost point of the body. However, these supports cannot be used where it is necessary to move poles suspended from the derricks. Also, the springs in the trucks are strong enough to handle, unaided, all of the light and some of the medium-sized poles without the use of the pole derrick supports, so that the stability from a short body overhang back of the rear axle becomes a very desirable feature in construction and maintenance trucks.

For highway delivery of such items as reels of cable, crossarms, conduit material, etc. open stake bodies, such as the type "M" unit are applicable. While the M bodies have not as yet

been standardized, they are mentioned as representative of a class. In these trucks, special attention must be given to the under supports and the floor construction, in order to carry safely the concentrated load which, in the case of some reels of cable, might amount to as much as three tons' pressure under one narrow reel flange. Other features of design in connection with this body have to do with suitable provision for tying down full and also empty reels, together with the proper width and length of body to accommodate the desired amount of material to be carried at any one time.

A rather highly specialized type of delivery body is used with four-wheel-drive trucks for carrying reels of cable on private right-of-way. These trucks have been used very successfully in Long Lines work, to replace slow-moving caterpillar tractor trailer outfits. They have not as yet been applied outside the Long Lines Department. Provision is made in this design for easily loading and unloading the heavy reels of cable and for holding them in position during the rough lurching ride which they experience when being hauled over private right-of-way. These four-wheel-drive outfits, equipped with powerful engines and very large pneumatic tires—dual in the rear and, when desired, also in the front—can negotiate unbelievably difficult private right-of-way conditions. It has been demonstrated on the job that they will deliver reels of cable to practically any place where this can be done with caterpillar tractors. Obviously, their use results in a considerable saving in cost as well as in time, due to their much higher speed and to the fact that they can be used to pick up a reel of cable at a railroad siding and deliver it to location, as compared with the older method of hauling the cable by truck to the edge of the right-of-way, where the reels are unloaded and then picked up by caterpillar tractor trailer outfits. A very strong steel reinforced body of comparatively small size is used in the trucks which handle this work.

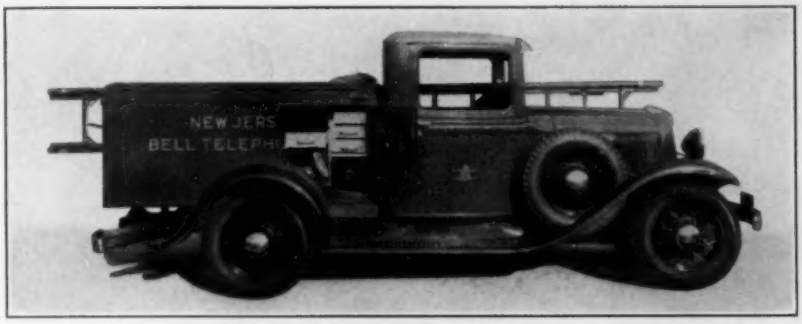
As representative of present day truck body development in

another branch of the telephone field, the experimental supply delivery panel outfit might be mentioned. This large body carries supplies from central storerooms to garages at night, where the many items required by various installation, construction, and maintenance trucks are taken from the supply delivery body and distributed directly to the trucks which will use the supplies on the following day. The body is built as low as practicable, in order to reach easily all portions of the shelving from the outside. Long doors on each side of the body, hinged at the bottom, open down to a horizontal position, where they rest upon telescoping pipe supports pulled out from underneath the body. In this horizontal position the large aluminum doors serve as platforms from which all portions of the shelving can readily be reached. The bank of shelving facing out on each side of the body is of the commercial storeroom type, except that it is made of aluminum alloy in order to reduce weight. A convenient step is provided for the use of the operator in stepping up and down from the floor to the platform. When closed, these doors form a water-tight cover for the lower portion of the shelving; the upper portion is covered by light, strong metal and fabric curtains carried in weatherproof guides.

Inside this supply delivery body, between the two panels of shelving, is an aisle which extends along the middle to the front of the body and across the front, with doors at the rear and on one side in front. Since, with this design, access to the shelving is not necessary from the inside of the body, the T shaped space inside is filled with bulky supplies which are removed as required and which do not interfere with access to the small material from the outside.

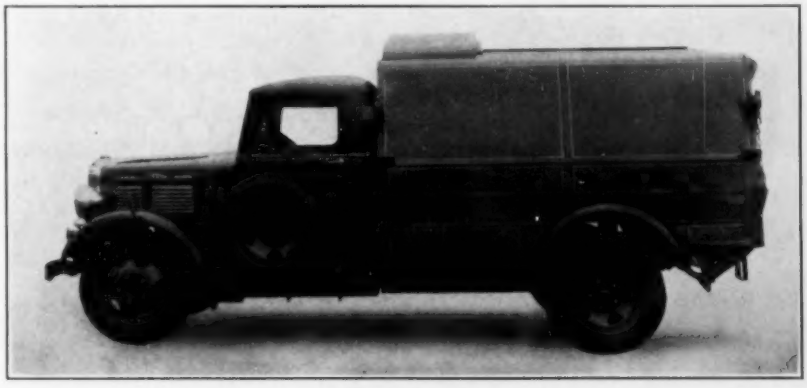
In order to permit easy maneuvering of this unit, with its long body, and also to economize in space required at the loading platform, a "camel back" (engine under the cab) type of chassis is being utilized.

As a further development in the supply delivery field, a de-



THE CS TYPE VEHICLE.

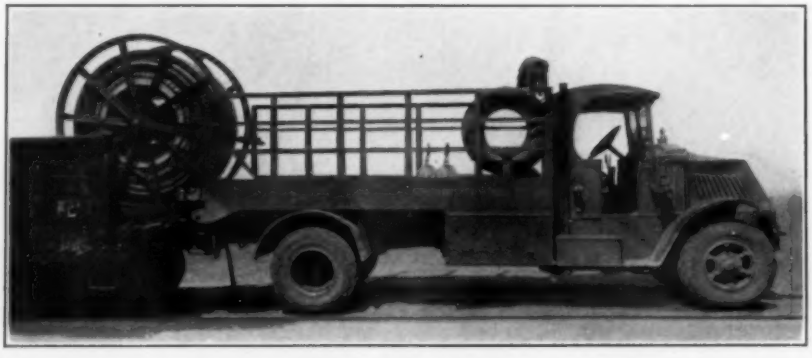
For the use of the splicer-repairman; this body is fabricated of aluminum alloy, to permit of a large body on a small chassis.



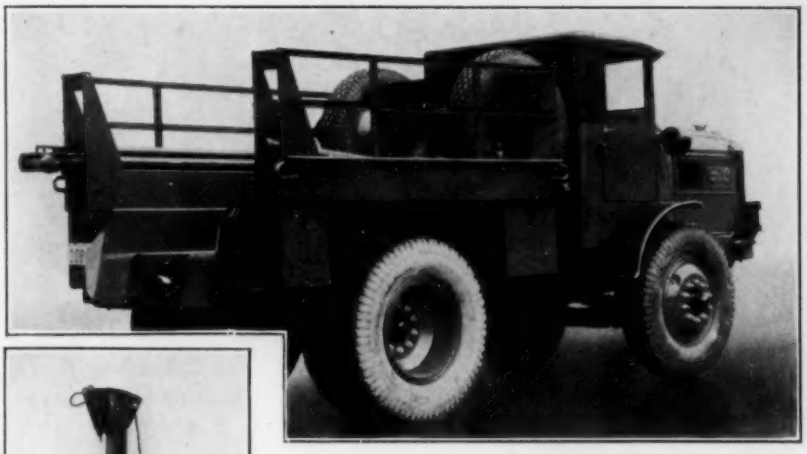
THE LCW TYPE VEHICLE.

A light truck with ample storage and auxiliary power facilities, to serve small construction and maintenance gangs.

THE MC TYPE VEHICLE.
A medium duty construction and maintenance truck.

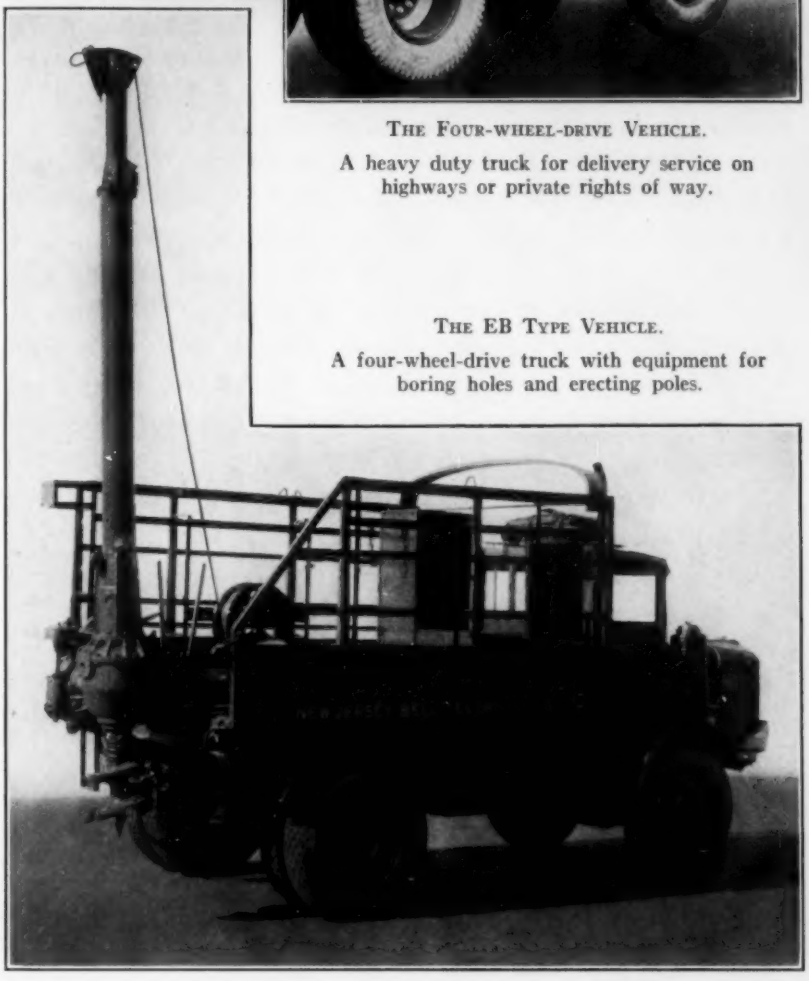


THE M TYPE VEHICLE.
A heavy duty delivery truck.



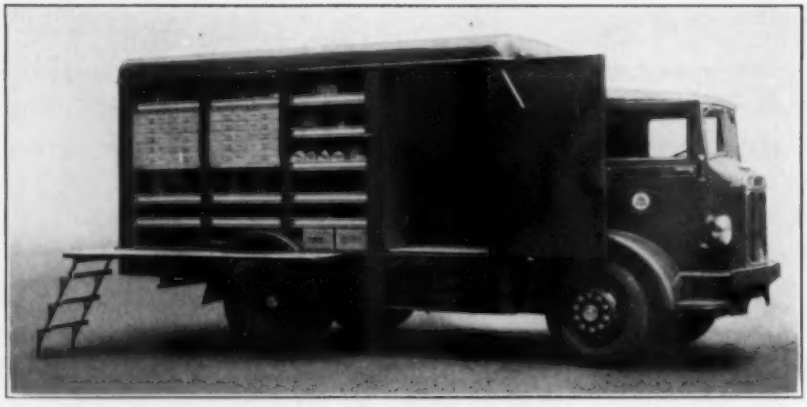
THE FOUR-WHEEL-DRIVE VEHICLE.

A heavy duty truck for delivery service on highways or private rights of way.



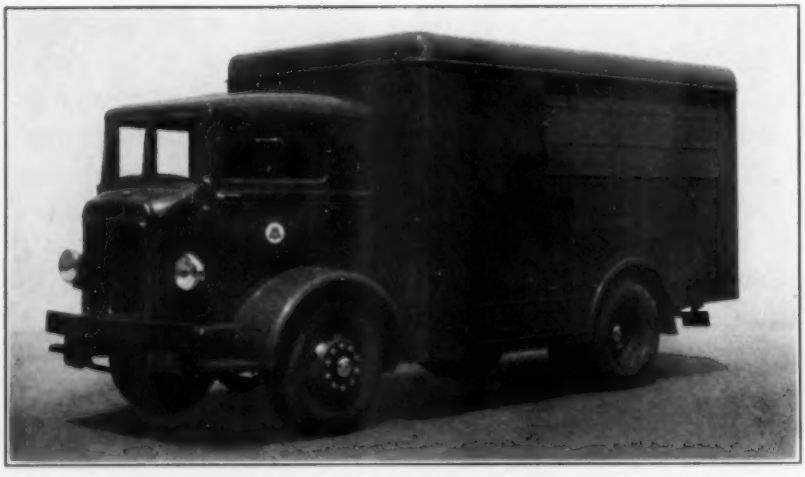
THE EB TYPE VEHICLE.

A four-wheel-drive truck with equipment for boring holes and erecting poles.



THE SD TYPE VEHICLE.

For carrying supplies from central store rooms to garages, where working trucks are loaded at night in preparation for the next day's work.



THE SD TYPE VEHICLE.

Showing the body closed, and the "camel back" type of front construction

sign has just been completed covering a body coded "SD," of practically the same size as the one mentioned above but having radically different features. Access to the shelves in the SD body is entirely from the inside. The space occupied by the shelving is practically the same as in the earlier body, but the shelving, in sections, is carried on four specially designed, castor mounted, hand trucks, each of which when loaded will weigh approximately 1200 pounds. These hand trucks are rolled out of the body and left in the storeroom during the daytime to be filled, while the truck is available for delivering booths or other supplies. In the evening the truck is returned to the storeroom; the loaded hand trucks, which, due to their design, can be handled by one or two men, are rolled into the positions provided for them in the truck body and clamped into place; and, as with the earlier body, the supplies are delivered to the waiting vehicles in various garages.

From the descriptions of features incorporated in these various representative truck bodies for their several types of work, it is evident that in order to handle this work economically and expeditiously, it is very desirable that each class of vehicle be studied with a view to adapting it to the type of service in which it will be used. Ordinarily in telephone work there is very little necessity for shifting a vehicle from one general class of work to another, and since a unit will probably be operated in a particular kind of service for from four to eight years, foresight in properly adapting the body to carry its greatly diversified load will pay large dividends through assisting the workmen in their day-to-day assignments over this long period of time. Another factor, which has only been mentioned and which is given very careful consideration in all designs, is that of safety both to the public and to the workmen. When tools and materials, particularly of the heavy types, are carried in an orderly manner and provision is made for properly securing them in place, an important step has been taken toward safe operation.

By careful study, the number of types of bodies in the field is kept at a minimum consistent with proper utility, in order to obtain quantity production and thus lower prices in the manufacture. Taking the average vehicle life at five or six years for the 17,000 vehicles in the Bell System fleet, and considering the fact that a very large majority of these are work cars, it is realized that the average annual turn-over in work cars is large. As a result, there arises the important opportunity for securing beneficial results from proper truck body designs.

T. C. SMITH

A Decade of Awards to the Scientists and Engineers of the Bell Telephone System

THE Hall of Fame, overlooking the majestic Hudson as it nears the ocean at New York, commemorates those famous men and women who have been deceased at least a quarter-century. Twenty-five years must elapse after death before a great personage becomes eligible for inclusion in its roster. There is a general impression that oftentimes merit, talent, and genius are not rewarded during one's life—that appreciation and recognition are often belated. Happily, this impression is in many cases incorrect. Medals, prizes, and orders awarded to men and women in many fields of endeavor —science, education, social service, religion, politics, engineering, et cetera—are frequently described in current magazines and newspapers, and, in these cases, the living person has the gratifying knowledge that his work has been acceptable to his profession and to his own age.

The engineers and scientists of the Bell Telephone System have been especially honored by contemporary organizations at home and abroad in the recognition accorded their achievements in the art and practice of electrical communication. Of the men and their work in this field of endeavor, Dr. Frank B. Jewett, President of the Bell Telephone Laboratories, in a recent address before the National Academy of Sciences, spoke as follows:

"Obviously, an achievement so intricate and vast as the whole of present-day electrical communication has been contributed to by many men in many lands. Their contributions have been of science, inventions, engineering, organization, and operation. With full credit to all others it is, I think, no derogation to say that electrical communication is essentially and

most largely an American thing, possibly our greatest and most unique contribution in the field of applied science. . . ."

That electrical communication is "possibly America's greatest and most unique contribution in the field of applied science" is attested by the number of medals, prizes, and awards that have been given to engineers and scientists of the Bell Telephone System. In the last decade, academies of science, institutions of engineering, and foundations, in America and abroad, as well as foreign governments, have recognized twenty-six outstanding contributions by living members of the technical staff. That during 1935, seven men have been awarded distinguished honors by one foreign government, two foreign scientific societies, and three American organizations, is particularly worthy of note.

The researches and accomplishments of the men of the Bell Telephone System who have thus been signally recognized with medals, prizes, and orders are briefly described in the pages which follow.

1925. THE JOHN SCOTT MEDAL

Awarded by the City of Philadelphia to

WILLIAM G. HOUSEKEEPER

Metals and glasses do not ordinarily stick to one another. At high temperature, when glass is in liquid form, it was found it would wet, that is, stick to copper. Later, at ordinary temperature, the two substances still adhered. In order to make high-power thermionic vacuum tubes for radio telephony and broadcasting, metal and glass must so adhere as to give an hermetic seal. Copper-glass seals usually fail because of the shrinkage of the copper away from the glass. Mr. Housekeeper discovered that this shrinkage can be prevented if either of the two substances is thin enough in comparison with the other so that it can be stretched or compressed by its heavier team-mate. Due to its great ductility, copper is usually se-

lected as the element to yield during cooling. From the metal part of the tube, heat necessarily accompanying the operation of the tube can be dissipated by water running in contact with it. The John Scott Medal is awarded by the City of Philadelphia from the proceeds of a fund left more than one hundred years ago by John Scott of Edinburgh, Scotland.

1925. THE MORRIS LIEBMANN MEMORIAL PRIZE

AWARDED BY THE INSTITUTE OF RADIO ENGINEERS TO

JOHN R. CARSON

Mathematics was recognized in the awarding of the Morris Liebmann Memorial Prize by the Institute of Radio Engineers to Mr. John R. Carson, a distinguished physicist and engineer. Mr. Carson discovered a new and improved and more efficient system of radio and wire transmission by means of mathematical investigations. "Single sideband, suppressed carrier system of wave transmission" is the technical name given to the invention. Electric circuit theory and the theory of selective circuits are also mentioned in the citation of Mr. Carson's work.

This Institute of Radio Engineers prize was established in 1919 by Mr. E. J. Simon now an electrical manufacturer of New York, in memory of Lieutenant-Colonel Morris Liebmann, killed in action in France in 1918. Mr. Liebmann was one of the early manufacturers of wireless and associated electrical equipment of 1900–1915.

1926. THE JOHN SCOTT MEDAL

AWARDED BY THE CITY OF PHILADELPHIA TO

GUSTAF WALDEMAR ELMEN

Where dynamic electricity is, there also is magnetism. Magnetic materials play as important a rôle in communication as do copper wires and batteries and switchboards and poles.

In every telephone receiver and every telephone circuit, one or more magnets will be found. For new and striking discoveries in magnetic alloys of iron, nickel, and cobalt, and particularly the invention of permalloy, an alloy of nickel and iron, Mr. Elmen was awarded the John Scott Medal by the Board of City Trustees in Philadelphia. As found in nature, iron, nickel, and cobalt individually possess magnetic properties serviceable for the needs of man. However, by alloying, the resultant metal possesses the same properties different in degree by many-fold less or many-fold more, and thereby serves better than the native substances.

Permalloy finds most striking use in the cores of telephone transformers and "loading" coils and in certain telephone receivers, and also in the adding of magnetic properties to submarine telegraph cables whereby a cable is enabled to carry several-fold more words per minute than previous types of cable.

1926. THE PHOTOGRAPHIC MEDAL

AWARDED BY THE ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN TO

F. F. LUCAS

To photograph what the eye cannot of itself see, oftentimes gives a clue as to the acceptability of material for use in telephone apparatus. For extraordinary ability to manipulate, control, and operate photomicrographic apparatus and for his exhibit of high power microphotographs of metallurgical specimens, Mr. Lucas was awarded the Photographic Medal of the Royal Photographic Society of Great Britain.

1927. THE MORRIS LIEBMANN MEMORIAL PRIZE

AWARDED BY THE INSTITUTE OF RADIO ENGINEERS TO

RALPH BOWN

In 1927, commercial radio telephone service was established between America and Europe. Today, many commercial radio telephone circuits connect the United States with South America, Honolulu, the Philippine Islands, Bermuda, many other countries, and ships at sea. Ninety-three per cent of the world's telephones may be reached from the United States by radio and wire circuits.

Prior to 1927, many researches on a wide front were conducted in the field of radio transmission under the direction of Mr. Ralph Bown. In recognition of his researches in wave transmission phenomena, he was awarded the Morris Liebmann Memorial Prize. He has been an outstanding exponent of the development of methods and equipment to place radio on a quantitative and engineering basis rather than on a hit-and-miss and qualitative basis.

1927. THE JOHN SCOTT MEDAL

AWARDED BY THE CITY OF PHILADELPHIA TO

HERBERT E. IVES

A Chinese proverb states that one picture is worth a thousand words. Electrical circuits carry speech and telegraph signals and, in addition, may be used for the transmission of electrical impulses to control a source of light which eventually affects an undeveloped photographic plate. For his share in the development of a method for transmitting pictures over telephone lines and for the further development of television either over land wires or by radio, Mr. Herbert E. Ives was awarded the John Scott Medal. John Scott, a native of Scot-

land and later a resident of Philadelphia, wished to honor scientists "responsible for useful inventions for the use and benefit of mankind."

1928. THE JOHN FRITZ MEDAL

AWARDED BY THE FOUR MAJOR ENGINEERING SOCIETIES OF THE UNITED STATES TO

J. J. CARTY

General J. J. Carty, formerly Vice President of the American Telephone and Telegraph Company, was for many years its Chief Engineer and later had charge of its development and research program. Under his leadership and inspiration, many outstanding developments in the communication art and business were conceived, planned, developed and put into practice. His imagination foresaw, his mind planned, and his skill fashioned many creative advances in radio and wire telephony. Throughout the many years of his active life, he was literally showered with degrees, honors and medals.

In 1928 the four major engineering societies of Mechanical, Electrical, Mining and Metallurgy, and Civil Engineering awarded General Carty the John Fritz Medal. The Medal was established in 1902 in honor of John Fritz of Bethlehem, Pa., a pioneer in the steel industry. The citation for this medal reads "For pioneer achievement in telephone engineering and in the development of scientific research in the telephone art."

The first medal awarded to General Carty was the Edward Longstreth Medal of the Franklin Institute in 1903. In 1916 the Franklin Medal, the highest award within the gift of the Franklin Institute, was given to him at a "Carty-Hall" meeting in Philadelphia. On this occasion a demonstration of wireless and transcontinental telephony was presented. New York had at that time been talking to San Francisco on a commercial telephone basis for about a year. The Thomas A. Edi-

son Medal was awarded to him in 1918 for "work in the science and art of telephone engineering."

For notable work in the Signal Corps during the Great War, he was awarded the Distinguished Service Medal by the United States Government in 1919 and was made "Officier de Legion d'Honneur" by the French Government in the same year. The Japanese Government honored General Carty by naming him to the Order of the Rising Sun in 1909 and the Order of the Sacred Treasure in 1912.

1928. THE ELLIOT CRESSON MEDAL

AWARDED BY THE FRANKLIN INSTITUTE TO

GUSTAF WALDEMAR ELMEN

This medal was founded in 1848 by Elliot Cresson, a merchant and philanthropist of Philadelphia. It is awarded annually for "discovery or original research adding to the sum of human knowledge, irrespective of commercial value, and also leading to practical utilizations of discovery." This medal, as was the John Scott Medal in 1926, was given to Mr. Elmen for extended researches in the magnetic characteristics of nickel-iron alloys resulting in permalloy.

The Franklin Institute of Philadelphia, named in honor of America's first great experimenter in electricity, was founded in 1824. One of its purposes is to "present, exhibit or discuss new inventions, discoveries or important engineering projects and notable achievements in all fields of scientific progress."

1928. THE JOHN SCOTT MEDAL

AWARDED BY THE CITY OF PHILADELPHIA TO

H. D. ARNOLD

In the address of Dr. Jewett before The National Academy of Sciences, previously referred to, he said: "Before 1915, nature could say to man, 'there are limitations of distance be-

yond which you cannot go in intimate and personal conversation with your fellow-men; you must work out your destiny within this limitation.' After 1915, man could say to nature: 'there are no limits of distance or physical circumstance which you can any longer impose upon me as regards my need or desire to speak face-to-face with men anywhere; from now on I propose to work out my destiny free from this shackle of the past.'"

One of the instrumentalities, a key, as it were, which unlocked the confining doors, was the vacuum tube, the result of the brilliant research in electronics of a number of workers, one of whom was Mr. H. D. Arnold. In 1912, the "audion" of Dr. Lee de Forest was a very crude device, incapable of being used as an amplifier of voice currents in long distance telephony. Mr. Arnold recognized the possibilities inherent in this device and undertook a development which, starting on the basis of the "audion," resulted in the production of the modern three-electrode high-vacuum thermionic tube. It is adaptable to a wide range of purposes and was specifically developed by him for commercial use in long distance wire and radio communication.

Mr. Arnold's particular contributions were the appreciation of the necessity of a high vacuum and a development and application of methods for obtaining such a vacuum. He developed designs for tubes and methods for their manufacture so that they could be reproduced with accuracy and so that dependable and interchangeable tubes could be made to meet telephonic requirements of reliability and ease of maintenance.

While a telephone conversation between Los Angeles and New York is taking place, over 200 thermionic vacuum tubes are functioning in the telephone repeater and transmission apparatus. The greatest distance with which man has to deal is "around the world," since talking to "the man in Mars" would involve celestial rather than mundane distances. In the summer of 1935, a round-the-world telephone call, from New York

to New York, was made, in which 980 vacuum tubes played their versatile rôles. At the present time there are about 350,000 vacuum tubes in the Bell Telephone wire and radio systems.

For his notable researches Mr. Arnold was awarded the John Scott Medal " for the development of the three-electrode high-vacuum tube."

1928. THE COMSTOCK PRIZE

Awarded by the National Academy of Sciences to

CLINTON J. DAVISSON

Electrons have been the subject of study and research by many distinguished scientists: Sir Joseph Thomson of Great Britain, Lorentz of Holland, Millikan of the United States, and many others. In the field of vacuum tubes for radio and wire telephony, the word " electron " has become a word in the vocabulary of day-to-day conversation even in lay circles. It was generally considered that an electron was a discrete particle of negative electricity. However, through experimental work Mr. Davisson demonstrated that under certain conditions electrons behave as trains of waves might be expected to behave. Electrons were diffracted when a stream of them was shot into a suitable crystal, nickel for example. Diffraction is a well known and simple phenomenon, always accepted as proving that light was a wave phenomenon. The striated or narrow-lined structure of birds' feathers, producing by reflected light beautiful iridescent color effects, is an example of the phenomenon of diffraction. According to Laue and Bragg, the atoms in a crystal are arranged in regular patterns of various types. Hence, if electrons shot at a crystal emerged in a few sharply defined beams, the phenomenon is similar to the reflection of light from the striated structure of a feather. If electrons were diffracted, they were behaving as trains of waves.

Every five years the National Academy of Sciences awards

the Comstock Prize "for the most important discovery of or investigation in electricity or magnetism or radiant energy." To Mr. Davisson it was granted "for experimental work demonstrating that under certain conditions electrons behave as trains of waves might be expected to behave."

General C. B. Comstock was a distinguished engineer and soldier during the years of the Civil War, retiring from the U. S. Army in 1895. He was a pioneer in geodetic survey work.

1929. THE EDISON MEDAL

AWARDED BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS TO

FRANK B. JEWETT

Annually a committee of twenty-four members of the American Institute of Electrical Engineers awards the Thomas A. Edison Medal "for meritorious achievement in electrical science, electrical engineering, or the electrical arts." In his response at the presentation of this medal, Dr. Jewett said: "The history of the development of telephony is one of coöperative effort with scarcely a parallel in the domain of applied science. . . . Nowhere else is the industrial research organization more potent, more firmly incorporated into the business structure, or more relied upon as a weapon of attack on problems yet unsolved. . . .

"As one who has been a part of the unfolding pageant of telephony for the past 25 years, I am not unmindful of the influence others have had in whatever I have accomplished. In accepting this medal, the highest and most cherished honor which American Electrical Engineers have it in their power to bestow, I do so, therefore, with a deep feeling that in large measure I am accepting your appreciation for the work of all the numerous men who have been my intimate associates. On

their behalf as well as my own, I thank you for your signal recognition of our endeavors."

In 1919 Dr. Jewett was awarded the Distinguished Service Medal by the United States Government, "for exceptionally meritorious and conspicuous service in connection with the development of the radio telephone and the development and production of other technical apparatus for the Army."

1929. THE PHOTOGRAPHIC MEDAL

AWARDED BY THE ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN TO

F. F. LUCAS

Recognition of the outstanding work of Mr. Lucas in the application of photomicrography to metallurgy was made by the awarding of the medal of the Royal Photographic Society of Great Britain in 1926. For his application of photomicrographs of living tumor cells taken by means of ultra-violet light, he was again awarded the medal of the same society in 1929. These photomicrographs show for the first time his new method of optical sectioning. Just as the microscope reveals horizons not visible to the naked eye, so, most interestingly, ultra-violet light, by which the human eye cannot see, enables the microscopic eye to see still wider horizons. The technician says that, since the wave-length of ultra-violet light is less than that of visible light, the resolving power of the microscope is greater than that of the human eye. In the end, therefore, photographic plates (artificial chemical retinas) show the minutiae of structure in pictures taken with light to which human retinas do not respond with a sense of vision.

1930. THE DUDLEY MEDAL

AWARDED BY THE AMERICAN SOCIETY FOR TESTING MATERIALS TO

J. R. TOWNSEND AND W. A. STRAW

Seemingly more prosaic problems than those presented in the work of the medal winners named above are those problems dealing with strength, wearing properties, resistance to rust, hardness. However, in constructing and erecting and supporting telephone apparatus in central offices and out of doors, problems connected with the above properties become very real and have wide economic value. For their work embodied in the paper "Physical Properties and Methods of Testing for Some Sheet Non-Ferrous Metals," Mr. Townsend of the Bell Telephone Laboratories and Mr. Straw of the Western Electric Company were awarded the Dudley Medal.

Dr. C. B. Dudley, formerly Chief Chemist for the Pennsylvania Railroad was one of the organizers and the first President (1902–1909) of the American Society for the Testing of Materials. The medal was established in his honor in 1925.

1930. THE THIRD ORDER OF THE SACRED TREASURE

AWARDED BY THE EMPEROR OF JAPAN TO

FRANK B. JEWETT

The Order of the Sacred Treasure is conferred by His Majesty the Emperor of Japan. At a meeting in New York, the diploma and decoration of the Order were presented to Dr. Jewett on behalf of the Emperor by the Consul-General of Japan, "in appreciation of the most valuable services in the development of the telephone and telegraph industry in Japan." Dr. Jewett also holds the Fourth Order of the Rising Sun, likewise conferred by the Emperor of Japan in 1923.

1931. THE ELLIOT CRESSON MEDAL

AWARDED BY THE FRANKLIN INSTITUTE TO

CLINTON J. DAVISSON

Further recognition of the distinguished researches of Mr. C. J. Davisson was made by the Franklin Institute in awarding the Elliot Cresson Medal "in consideration of pioneer work in the scattering and diffraction of electrons by crystals and of its direct bearing on our theory of the constitution of matter."

1931. THE ELLIOT CRESSON MEDAL

AWARDED BY THE FRANKLIN INSTITUTE TO

L. H. GERMER

Associated with Mr. Davisson in his researches has been Mr. L. H. Germer, and to him also was awarded an Elliot Cresson Medal. Messrs. Davisson and Germer were able to calculate from their experiments the "wave-length" of electrons, and the values obtained check closely with those announced by de Broglie in France.

1931. THE JOHN PRICE WETHERILL MEDAL

AWARDED BY THE FRANKLIN INSTITUTE TO

E. C. WENTE

The conversion of the sound waves of speech into electrical impulses was the notable discovery of Alexander Graham Bell. In the transmitters of the more than 33,000,000 telephones in the world, this conversion is daily accomplished through the medium of carbon granules. It is recognized today that there are several methods by which this conversion can take place. In other words, there are several kinds of distinctly different electrical ears which can hear sounds. One of these electrical ears or microphones is known as the electrostatic transmitter,

consisting essentially of two thin metallic membranes placed very close to each other. When sound waves strike one of the plates, the electrostatic condition of the plates is changed and a tiny electric current results. This transmitter had received relatively little attention and development work because it was so very insensitive to sound waves and needed an amplifier immediately associated with it to enlarge the very tiny electric currents to which it gave rise. The invention of the vacuum tube amplifier overcame this insensitivity and made it possible for Mr. E. C. Wente to proceed with the development of a practical electrostatic transmitter. It was found that, to compensate for its great insensitivity, it would hear with great fidelity and could be used at times where the esthetic values of music and the dramatic values of speech were more essential than in everyday telephone conversation. This electrical ear became a "Mike" in broadcasting studios. For his work on and development of the electrostatic transmitter, the John Price Wetherill Medal was conferred on Mr. Wente.

John Price Wetherell was another of those early Philadelphians interested in science and its application to industry. He called himself a manufacturing chemist and was of the 1840 era.

1932 THE MORRIS LIEBMANN MEMORIAL PRIZE

Awarded by the Institute of Radio Engineers to EDMOND BRUCE

The great advantage of telephonic communication by wire is that the conversation between the persons concerned is direct and private. Each day in the United States over 75,000,000 of these individual, personal, two-way telephone calls are made. On the other hand, radio waves lend themselves admirably to the situation where it is desirable to have many persons listen to one voice, as is the case in radio broadcasting. If radio waves are left to their own simplest devices, they will

spread and radiate in all directions. However, in certain circumstances of radio telephony, it is highly desirable that the radio waves go in a particular direction with a much greater degree of efficiency than in some other direction. This is true of light waves where reflectors are used to send light waves in a beam to some particular point. In radio waves the expression "beam systems" has therefore come into vogue. The Institute of Radio Engineers recognized the very important work of Mr. Bruce in this problem of developing antennas which would send their radio waves better in one direction than in another. "For his theoretical investigations and field developments in the domain of directive antennas" he was awarded the Morris Liebmann Memorial Prize.

1932. THE EDISON MEDAL

AWARDED BY THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS TO

BANCROFT GHERARDI

The Communication facilities of the Bell System have grown with the nation. To engineer them, construct them, maintain and operate them has called for a rare combination of engineering knowledge and of executive force and wisdom. Forty years of engineering accomplishments is the span of Bancroft Gherardi's notable contribution to American telephony. He had as his responsibilities such important undertakings as the first long underground cable from Boston to Washington; the vast transcontinental telephone project; the introduction of dial operation in large cities; and many other outstanding advancements in communication. As Chief Engineer and Vice President of the American Telephone and Telegraph Company, he has supervised a far flung activity that only those can appreciate who remember the vastness of America and the complexity of her communication needs. His part has been a distinguished one in the creation of communication services,

and in the development of the men and women on whose loyalties and abilities must rest the progress of any great undertaking.

In 1928, when Mr. Gherardi was President of the American Institute of Electrical Engineers, he dubbed General J. J. Carty the dean of telephone engineers. That appropriate soubriquet may now fittingly be applied to Mr. Gherardi. "For his contributions to the art of telephone engineering and the development of electrical communication," is the citation accompanying the award to him by the American Institute of Electrical Engineers of the Thomas A. Edison Medal.

In 1923 the Emperor of Japan conferred upon him the Emblem of the Fourth Order of the Rising Sun.

1935. THE JOHN PRICE WETHERILL MEDAL

Awarded by the Franklin Institute to

F. F. LUCAS

Further recognition of the outstanding contributions of Mr. Lucas in the field of photomicrography was made in the award to him of the John Price Wetherill Medal by the Franklin Institute of Philadelphia. The citation reads: "This medal is awarded in consideration of his development of a technique of microscopy and photomicrography by virtue of which objectives of the highest numerical aperture yet developed and visible light and ultra-violet light have been brought to their full theoretical resolving power, and by the use of which photomicrographs of metallurgical and biological specimens superior to any heretofore made are now being produced under his direction."

The capability of the human eye, the microscopic eye, or the telescopic eye to see separate lines or dots which are close together as separate lines or dots, relates to the resolving power. A picket fence at a quarter-mile is just a white wall, but at a hundred feet is a fence, with discretely seen pickets. That

ultra-violet light, shorter in wave-length than visible light, gives greater resolving power and thereby makes possible the revelation of greater detail in photomicrographs, was taken advantage of by Mr. Lucas in his expert technique.

1935. THE FARADAY MEDAL

AWARDED BY THE INSTITUTION OF ELECTRICAL ENGINEERS (GREAT BRITAIN) TO

FRANK B. JEWETT

Michael Faraday of Great Britain is sometimes called the greatest experimenter of electrical science in the history of the world. In 1931 the centenary of one of his greatest discoveries was celebrated. The principle of magnetic induction is the basis of the keystones of practically all branches of electrical engineering. In 1931, Dr. Jewett, in America, spoke by transatlantic telephone to a distinguished audience gathered in London to celebrate the Faraday discovery. On that occasion Dr. Jewett said: "In a way, there is something peculiarly fitting in this tribute which I bring you and in the manner of its delivery. Involved in it is probably more of the fruit of Faraday's works than can be encompassed in any other single happening in our modern world. For me to sit here in Boston, where Alexander Graham Bell made his great invention, based on Faraday's discovery, and address you in London, requires the application of something of all that men have learned in a hundred years in the fields to which Faraday opened the gates."

To commemorate the life and the work of Faraday, the Institution of Electrical Engineers of Great Britain established the Faraday Medal and it is awarded "either for notable scientific or industrial achievement in electrical engineering or conspicuous services rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership in the Institution."

The 1935 Faraday Medal was awarded to Dr. Jewett, Vice

President of the American Telephone and Telegraph Company, and President of the Bell Telephone Laboratories. In his acceptance of the Medal, Dr. Jewett reiterated the generous point of view that he had stated in accepting the Edison Medal of the American Institute of Electrical Engineers in 1929: "I therefore feel that my chief rôle during the past twenty years has been that of creating an organization designed to make industrial research profitable by turning to practical ends under controlled conditions a portion of the vast stream of new knowledge which is coming out of the world's fundamental research laboratories. . . . The achievements of the research laboratories of the Bell Telephone System are primarily the work of my associates, and in them there is relatively little personal credit due to me. In offering this brief expression of gratitude to the Institution for conferring the Faraday Medal upon me, I therefore take great pleasure in joining it with a tribute to my many associates, who have been loyal friends and coadjutors all these years."

1935. THE EDWARD LONGSTRETH MEDAL

Awarded by the Franklin Institute to

EDMOND BRUCE

Mr. Bruce, to whom was awarded the Morris Liebmann Memorial Prize of the Institute of Radio Engineers in 1932, was awarded the Edward Longstreth Medal "in consideration of his design and development of antennas for short-wave communication, combining superior efficiency, higher directivity, simple construction, and effectiveness over a broad range of frequencies." These antennas have greatly improved transoceanic transmission and reception.

Edward Longstreth was a pioneer Philadelphia manufacturer interested particularly in steam locomotives. In 1890, a medal was established in his honor, to be administered by the Franklin Institute. Steam locomotives and short radio

waves are quite antipodal in their heritage and utility. However, science knows no castes.

1935. THE MORRIS LIEBMANN MEMORIAL PRIZE

AWARDED BY THE INSTITUTE OF RADIO ENGINEERS TO

F. B. LLEWELLYN

As radio developments have progressed through the years, there has been increased understanding and utilization of short waves: waves one foot, three feet, ten feet long. Corresponding to these waves, the oscillations of electric current are designated as ultra-high frequencies, namely, 900,000,000; 300,000,000; 30,000,000 vibrations per second. The use of thermionic vacuum tubes in this field of ultra-high frequencies brought new problems and likewise new and smaller vacuum tubes, some of them being the size of an acorn. The Morris Liebmann Memorial Prize, won by three other Bell System engineers, was awarded to Mr. F. B. Llewellyn "for his analysis and descriptions of the effects and the reactions which occur within vacuum tubes at ultra-high frequencies."

1935. THE ORDER OF THE RISING SUN

AWARDED BY THE GOVERNMENT OF JAPAN TO

G. W. GILMAN

Radio waves ranging from 50,000 vibrations per second to 20,000,000 vibrations per second are used to span great bodies of water and link together the land telephone systems on the seven continents of the world. One of these channels of radio telephone service connects the United States and Japan. Mr. G. W. Gilman was sent to Japan in preparation for the building and putting into service of this radio telephone circuit. In recognition of his coöperative efforts in these preparations, Mr.

Gilman was presented with the Order of the Rising Sun by the Minister of Communications in Japan.

1935. THE PROGRESS MEDAL

AWARDED BY THE SOCIETY OF MOTION PICTURE ENGINEERS TO

E. C. WENTE

Electricity is a most versatile and amenable agent. In its own right it performs many functions, and, furthermore, it may be controlled by light and sound and in turn can control light and sound. The triumvirate—light, sound, and electricity—achieve a high place in the field of talking motion pictures. In recognition of his fundamental contributions and outstanding inventions in light, sound, and electricity as they apply to motion picture technology, Mr. Wente was awarded the Progress Medal. These inventions include microphones, those electrical ears which turn sound into electric current; light valves, used by the large producers of sound pictures, which are controlled by electric current and which in turn control sources of light to record the sound photographically on the film; and loud speakers, those electrical mouths which speak in accompaniment to the action on the screen. Microphones, light valves, and loud speakers—direct and indirect products of telephone technique—have been the field of research of Mr. Wente.

The Progress Medal recently established, is to be awarded from time to time as the Society decides upon outstanding contributions. Mr. Wente is the first recipient.

1935. THE DAVID HUGHES MEDAL

AWARDED BY THE ROYAL SOCIETY (LONDON) TO

CLINTON J. DAVISSON

The work of Mr. Davisson on electron diffraction has been recognized as an outstanding contribution in the field of atomic

physics. Recognition of this fact resulted in Mr. Davisson's being awarded two medals in America. Further recognition was given by the Royal Society of London in awarding him the David Hughes Medal. It is interesting to note that this same medal, established in 1900, was awarded to Alexander Graham Bell in 1913. Much of the outstanding work in atomic physics has been done in the Cambridge University Cavendish Laboratory, England. That the Hughes Medal was awarded to Mr. Davisson for his work in this field is particularly complimentary to American science.

The name of David Edward Hughes will ever be associated with printing telegraph instruments. Although born in England, 1831, his early years were spent in America. Returning to his native land, Hughes made important contributions to carbon microphones and discovered the action of the so-called "coherer" used in the early days of wireless telegraphy.

Most of the scientists and engineers whose honors have been recounted above hold the degree of Doctor of Philosophy. All but two are graduates and post-graduates of colleges and technical schools in the United States. The honorary degree of Doctor of Science has been awarded to these two who came to the research department after a number of years of practical work in the telephone operating field rather than academic halls. Only two of the entire galaxy are deceased.

Recognition of accomplishment, such as that discussed in the preceding pages, has of course always been a concomitant of the continuing development of the telephone art. Alexander Graham Bell during his lifetime received upwards of 30 medals and decorations, as well as a number of honorary degrees. The James Watt Medal in 1877, the Royal Albert Medal in 1878, the Volta Prize in 1880, the Decoration as Officier de Legion d'Honneur in 1881, the John Fritz Medal in 1907, the Elliot Cresson Medal in 1912, the David Hughes Medal of the Royal

Society of London in 1913, the Edison Medal in 1914, and the Medal of Honor for Distinguished Public Service by the Civic Forum of New York in 1917, were among his more notable honors.

That the individual talents and achievements of men should be recognized, as indicated in the preceding pages, reflects the desire of men to honor personally their fellow-men. In contrast, it is particularly noteworthy when an industry, an organization, a company, is awarded a medal. The officers of the Franklin Institute of Philadelphia in 1916 awarded the Elliot Cresson Medal to the American Telephone and Telegraph Company. Mr. Theodore N. Vail, then President of the Company, accepted the award, on which the citation reads: "To The American Telephone and Telegraph Company, in recognition of its constructive and far-seeing policy in the development of the art of telephony; in the promotion of telephone engineering; in the establishment of its telephone system in every part of the United States, and for placing all of the States of the Union in speaking communication."

James M. Barrie wrote a beguiling tale of the World War, called "Seven Days' Leave," which was dramatized and made into a motion picture play with the title "A Lady Shows Her Medals." If those of the Bell System should ever be exhibited, there would indeed be an imposing collection. Such a display of awards will doubtless never be attempted. Therefore this account can only suggest that the quality and scope of America's telephone service constitute impressive evidence of the practical significance and utility of the scientific and engineering achievements thus recognized.

J. O. PERRINE

Notes on Recent Occurrences

DR. G. A. CAMPBELL, LEADING MATHEMATICAL SCIENTIST, RETIRES AFTER 38 YEARS

ON the first of December, 1935, after thirty-eight years of active and unusually productive service as a mathematical physicist and inventor, Dr. George A. Campbell retired from active membership on the staff of the Bell Telephone Laboratories.

In 1897, thirty-eight years ago, the art of telephone transmission was in its infancy. Circuits of even a few hundred miles' length were rare, and the longest distance over which communication had been held was that separating New York and Chicago. It was at this time that Campbell, as a young man, after graduating from Massachusetts Institute of Technology and spending four years in graduate study at Harvard, Gottingen, Vienna and Paris, joined the staff of the American Telephone and Telegraph Company to engage in research.

Some years before, Heaviside had suggested that inductance, if properly applied in a long telephone circuit, should diminish rather than increase the attenuation. Campbell followed this suggestion and developed a complete theory of loading. But in his case there occurred one of those coincidences—fortunately rare in the history of science—of two investigators arriving at substantially the same result at the same time. Independently, Professor M. I. Pupin had also attacked the problem. They both applied for patents, with the result that an interference was declared, and Pupin was able to establish a slightly earlier date of conception. The loading coil interference was decided in Pupin's favor and the famous patents issued to him. The fact should be recorded, however, that Campbell's analysis of the problem—actually more detailed

than Pupin's—led him to formulate rules for the design of loading coils and their spacing which were, from the very beginning, the only ones employed in this country.

As the effectiveness of telephone instruments increased and the lengths of circuits grew, noise and crosstalk became an outstanding obstacle to telephone advance. It had been shown that this crosstalk was a complex effect resulting partly from electromagnetic and partly from electrostatic induction. In unpublished memoranda written between 1903 and 1907, Campbell pointed out that crosstalk between two circuits depends, to a considerable extent, and particularly in the case of loaded circuits, on a function of the various direct capacities between the wires of two circuits. He termed this function the "direct capacity unbalance." This work led to the invention of the well-known capacity unbalance test set, hundreds of which have been used in countless measurements in the manufacture and installation of toll cables. It was also at this time that he designed his well-known "shielded" balance, which in one form is a bridge for measuring direct capacities.

As control was gradually extended over the characteristics of telephone circuits, both from the standpoint of their transmission effectiveness and their freedom from crosstalk and noise, the art reached the point at which development emphasis shifted to the telephone repeater. Here, an entirely new line problem arose,—namely, that of avoiding singing when repeaters are adapted to two-way amplification. Up to 1912, the only type of repeater circuit used was the so-called 21-type, in which a single repeater element amplifies messages which reach it from both directions and which requires that the two associated sections of line have very similar characteristics. A well-known limitation of the 21-type repeater is its tendency to "sing" when line unbalance or amplification exceed certain rather low limits.

On the other hand, the 22-type repeater has two amplifying elements and two artificial lines, one to balance each associated

section of actual line. While the basic idea of the 22-type was old, it remained for Campbell, in a memorandum dated March 7, 1912, to reveal its properties of inherent stability. Also his words, "the use of a compensating device such as an artificial line, to reduce the amplification at the resonant frequencies to the level of the amplification at other telephonic frequencies" suggest broadly the idea of equalizing for amplitude-frequency distortion which is brought in by the selective characteristics of the line circuits or other apparatus in a long system. Furthermore, "if it became necessary merely to eliminate certain frequencies lying outside of the range required for telephony, the use of an artificial selecting circuit" is definite anticipation of the use, subsequently common in all repeaters, of low-pass filters to cut off frequencies outside of the band transmitted and thus minimize line balance difficulties.

Campbell was also the originator of the "four wire" circuit. In the same memorandum of 1912 which discussed the 22-type repeater, he suggested it as the logical extension of the one-way paths in the 22-type repeater, each path containing as many one-way amplifiers and line sections as desired.

At present, particularly in toll transmission, we find a growing use of high frequencies, the transmission of broader frequency bands and the use of the so-called "carrier" method. The electrical wave-filter in its many forms is one of the most important elements in all such systems. Indeed, the filter has, within the last few years, become almost as ubiquitous as the vacuum tube. The fundamental conception of the electric wave-filter arose out of Campbell's analysis of loaded lines and a patent was issued to him in 1917.

Effective station sets are fundamental to all good transmission. In a memorandum dated October 8, 1906, Campbell disclosed the single-transformer anti-sidetone station circuit which is achieving almost world-wide acceptance. Later, he carried out a comprehensive survey, giving assurance that all types of

circuits were considered and that those which best fitted the available transmitters and receivers were selected.

This brief note is intended only to enumerate without elaboration the more outstanding of Dr. Campbell's contributions to the art of electrical communication as they fit into the history of that art. Their diversity is such as to establish the unusual versatility of Campbell's genius. His is a career unusually productive of discoveries, inventions and patents. Dr. Campbell's achievements in the field of telephone transmission entitle him beyond question to rank first among his generation of theoretical workers in electrical communication. Yet, in common with many truly great minds, it has been his nature to avoid publicity, so that outside the circle of his immediate associates and a few of the more mathematically gifted students of his chosen branch of electrical science, his fame is far from being commensurate with his achievements.

(*Condensed from a statement by Dr. F. B. Jewett in the Bell System Technical Journal for October.*)

HOLIDAY OVERSEAS CALLS SET NEW RECORD

OVERSEAS telephone calls handled through the Bell System's radio telephone stations on December 24 and Christmas Day and on December 31 and New Year's Day totaled 730 messages. This compares with 566 messages during the same four days a year ago.

More than 600 of the calls were handled through the overseas switchboards in New York: 293 on Christmas and 116 on the day before, 89 on New Year's Day and 103 the previous day. All these totals exceeded previous records established in 1934–35. The greater part of this traffic at New York was with Europe, 246 of the calls on Christmas Day involving European points.

Scores of distant lands figured in these holiday calls: Europe, Africa, India, Egypt, Australia and the Far East, Central and

South America; and also several ships on the high seas. Since day begins on the other side of the world from 13 to 15 hours before it does in this country, the calls from the Phillippines, Japan, and Australia arrived on December 24 and December 31.

Holiday calls of unusual interest handled over Bell System circuits included two between the Hawaiian Islands and Europe, one with London and one with Switzerland; two between Pennsylvania and Australia; one between Iowa and South Africa; one between California and Poland and another between California and India; and one between Canada and Denmark. Other distant places connected with points in this country included Cairo, Egypt; Stockholm, Sweden; Helsingfors, Finland; Santiago, Chile; Haifa, Palestine; and French Morocco.

NEW DISCOUNTS ON LONG DISTANCE CALLS ARE INTRODUCED

ON December 16, 1935, the American Telephone and Telegraph Company and the twenty-four Associate Companies of the Bell System filed with the Federal Communications Commission new tariffs which became effective on January 15, 1936. These schedules provide for reduced Sunday rates on interstate long distance calls, and also for reduced rates on interstate long distance person-to-person calls after 7 P.M., which apply generally where the day station-to-station rate is more than 35 cents. Similar changes in the rates for intrastate toll calls became effective on January 15, 1936, in most states.

For a number of years there have been discounts for long distance calls by number from 7 P.M. to 4:30 A.M. The new tariffs make all of Sunday a discount period, so that these reduced rates are in effect continuously from 7 P.M. Saturday to 4:30 A.M. Monday.

Hitherto there have been no discounts at any time on calls made to a particular person. Under the new schedules, with

minor exceptions, in any case where there is now a discount on number calls, there is also a discount on calls to a particular person. In addition, this discount applies to all day Sunday.

NEWCOMEN SOCIETY ELECTS WILLIAM CHAUNCY LANGDON

THE historical work of the American Telephone and Telegraph Company has received recognition from the Newcomen Society of England in the election of William Chauncy Langdon, Historical Librarian, to its membership. The Newcomen Society is devoted to the study of the history of engineering and technology. There are a number of American members,—eminent engineers, educators, and industrial executives. Charles Penrose of Philadelphia is the Vice President for America, and C. E. Davies, of the American Society of Mechanical Engineers, is the Secretary. The Executive Committee for America consists of Leonor F. Loree, who was the founder of the American branch, George B. Cortelyou, Newcomb Carlton, and William C. Dickerman.